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COMBINATION AND COMPETITION IN THE STEEL TRADE.

By T. Good.

While present economic conditions in the United States do not in the least presage depression, they do indicate some change in the rate and in the distribution of industrial activity. Any such period in the affairs of a great manufacturing nation means some shifting of interest from strictly domestic markets to export opportunities. The "American invasion" of 1897 is in no likelihood of being repeated, but American manufacturers may look with some interest upon the conditions of the metal trades of Great Britain and the Continent. Mr. Good's well informed review is therefore very timely, for it deals with the most important commercial conditions now prevailing in the steel trade, which in turn underlies all modern engineering industries.—THE EDITORS.

THE movement towards industrial combination, especially in the iron and steel trades, is very pronounced just now. This movement deserves something more than the thoughtless condemnation it too frequently receives. The history of the iron industry is marked throughout by violent fluctuations, and the need for some method by which such fluctuations might be moderated has long been felt. Then, again, Great Britain must recognize that so far as future foreign competition in iron and steel is concerned, one of her prime dangers lies in the circumstance that such competition is likely to be conducted by "trusts" and syndicates more powerful than in the past, while the opposition she may offer will be that of individual firms—that is, assuming that she unduly harasses, either by legislation or the pressure of an intolerant public opinion, the reasonable development of the combination movement among her manufacturers. Moreover, we must not forget that the British manufacturer must meet, not merely combined competitors in the world's markets, but combined workmen at home, and that both capital abroad and labour at home

tend to become more strongly organised. For these reasons we would do well to consider the efforts of our iron and steel makers to combine their efforts without prejudice.

Some time ago makers of shipbuilding and structural steel in Scotland and the North of England arrived at an understanding in reference to the regulation of prices and the allocation of orders, and on several occasions there have been more or less loose agreements in various branches of the British iron trade, although, owing to a variety of reasons which need not be specified, trusts, combines, and syndicates have not hitherto dominated British industries to anything like the extent that has obtained in Germany and America. But British manufacturers, despite their inherent conservatism, are being driven by sheer force of circumstances to recognise the need of some measure of organisation. In September last the steel-tube makers entered into a close arrangement for the control of their trade. About the same time there was formed a South Wales Siemens Steel Association. Early this year an Ironfounders' Combine was announced, and now we are informed that several of our very largest steel, engineering, and shipbuilding firms are joining forces in order to combat foreign competition more successfully. In these circumstances it is opportune to review briefly the past history of our iron and steel trades, as affected by competition, on the one hand, and by combination on the other. And we may venture a forecast of the possibilities of the future.

While we have had no very important or permanent trusts of the monopoly kind in Great Britain, it remains a fact that there have been occasions when, and markets where, our iron and steel makers have been practically at the mercy of American trusts and German syndicates. Whether we have been combined or not, we have had to compete with and submit to the trading methods and prices of combined rivals. Syndication, organisation, or whatever we may call it, is upon us, and no matter how strongly we may be opposed, either by conviction or prejudice, to some of the principles or effects of industrial combination, we have not only got to deal with combined labour in our workshops, but we have to meet, in the markets of the world, competitors enjoying all the benefits of closely organised production, sale, and transit. And we should frankly recognise that, whatever may be the merits or demerits of industrial combination—whether it destroys that healthy individualism which has been held to make for true progress or not—the iron and steel industries of Germany and America, with their large syndicates and trusts, have in recent years

made greater headway, and are now in a more progressive condition, broadly and generally speaking, than those of this country in which the sacred liberty of the individual has been so fondly cherished.

One of the most valuable object lessons available in industrial combination is that afforded by consideration of the inception, operation, and suspension of co-operative export bounties on German steel. Although a nominal bounty has been granted on certain classes of steel until the middle of this year, for all practical purposes the bounty system has been inoperative since June 30, 1906. But a brief review of the system—a system which may possibly be re-introduced in the near future—will be of interest. Introduced ten years ago by the syndicates controlling the coal, iron, and steel trades of Germany, this system of granting private bounties on steel and steel goods for export has exercised a considerable influence over the German steel trade, and has been largely instrumental in stimulating German competition with Great Britain. While the bounties were high "dumping" was indulged in to our undoubted detriment; as the bounties declined "dumping" diminished and our trade increased; since they have been withdrawn, or have been merely nominal, we have enjoyed a comparative "boom." Of course, there have been other factors influencing the situation, but the bounty system has been an important phase of a clearly organised movement, and as such demands attention.

In order to understand how those bounties were manipulated it is necessary to note that industrial syndication is more complete, and more effective, in the coal, iron, and steel trades of Germany than in any group of industries in any other country—not even excepting America, the home of huge trusts and prodigious things in general. The production, distribution, and price of practically every important article and material of manufacture in Germany, from coal and iron ore to sewing machines and wire, are regulated by some kind of syndicate. Ten years ago there were about ninety syndicates in the German coal and iron trades. Owing to absorption consequent upon improved organisation there are now about half that number. There are separate syndicates governing coal, coke, briquettes, lignite, and iron ore; pig iron, iron and steel castings, and foundry products; tubes, rails, girders, and rods; plates, light sheets, and heavy sheets; there are unions of electrical works, of sewing-machine makers, and of nail manufacturers. Besides syndicates for various products there are in some cases distinct syndicates where local conditions are of a special character. But these local, special, or sectional syndicates are

usually united with kindred trade syndicates, or work in harmony with one another. For example, while there are four distinct pig-iron syndicates, enjoying local autonomy, there is a Consolidated Pig-iron Syndicate controlling the local organisation. Then, in all but supreme authority, there is the famous *Stahlwerksverband,* or Steel Syndicate, which has recently been renewed for a term of five years.

These German syndicates are highly organised (but not on the American model) and, generally speaking, efficiently conducted. As evidence of the line of policy they usually adopt it may be mentioned that at a recent meeting of the Stahlwerksverband, when a member proposed a substantial increase in price in consideration of great pressure of orders, a counter-resolution was carried by a large majority to the following effect:—

"That moderate prices are the best guarantee of a continuance of purchasers, and that the mission of a trade syndicate is just as much to prevent an exaggeration of prices during times of activity as to support the courage of manufacturers during times of inactivity." Indeed, the directors of the Steel Syndicate have declared their policy to be "the preservation of the home market from violent fluctuations by providing constant work at moderate profits."

The usual methods of procedure adopted by the German syndicates are for a number of experts to visit each of the works associated, to ascertain its capacity of production and its aptitude for any special class of work. Orders, being received by the central offices, are then allocated and remitted to the several establishments, regard being paid to the situation and circumstances of the various firms so as to avoid waste, overlapping, and unnecessary delay. And not only are prices fixed and orders allocated by syndicated agreement, but payments usually pass through the central offices. Moreover, the syndicate frequently attends to times, methods, and costs of transit, and many other matters, with the greatest possible advantage to its constituents, for its expert officials are better informed than the private manufacturer immersed in the technicalities of his own particular works can hope to be. While different syndicates have different rules—some allowing their members more liberty of action than others—these may be taken as the general outlines of the working of German iron and steel syndicates.

It was in 1897 that the German syndicates inaugurated the export-bounty policy. The coal, the coke, the pig-iron, and other syndicates, and the Half-finished Goods Union, agreed to supply their associated customers—the rolling mills and steel manufacturers—with raw and

partly manufactured materials at lower prices when those materials were required for manufacturers for export than when needed for goods for the home market. From time to time the bounty rates, or differences between home and export prices, were increased or decreased in response to the fall or rise of the home demand—the primary object being to effect continuous running of the mills. When the home demand has been brisk the bounties have been low; when it has slackened the bounties have been put up in order to promote "dumping" abroad rather than resort to damping furnaces at home—with results well-known in this country.

Those export bounties sometimes represented a bonus equal to a reduction of one-third of the standard home price for such materials as ingots, blooms, and billets of steel. By these means German iron and steel goods have been sold in Great Britain below actual cost of profitable production. German plates, rails, girders, etc., have been sold in England at from 20s. to 30s. per ton cheaper than in Germany, and at less than our own cost price. Having no effective means of repelling this invasion of our markets we have witnessed the laying of imported tram rails in our streets, while many of our own furnaces, rolling mills, and workers have been idle. In one half-year the German Wire Rod Syndicate, while selling 22,000 tons at home at a profit of £58,000, exported 19,000 tons at a loss of £42,000. With the wisdom or unwisdom of this policy—with the economic effects of this policy either upon the "dumpers" or those who were "dumped" upon —I have no intention to deal, but merely wish to point out the powers and possibilities of organisation under certain fiscal conditions. As recently as 1905 the bounties granted on materials used in the manufacture of goods for export were as much as 1s. 6d. per ton of coal, 4s. 10d. per ton of pig-iron, 15s. per ton of semi-finished steel, and 20s. per ton of shapes—the bounty on steel including that allowed on coal and iron.

During the nine years, 1897-1905, in which the export bounties were in active operation, German exports of iron and steel goods increased from, approximately, 1,000,000 tons a year to 3,000,000 tons; imports decreased from 500,000 tons a year to 400,000 tons; pig-iron production increased from 7,000,000 tons a year to 11,000,000 tons; and steel production from 4,000,000 tons a year to 8,000,000 tons. With these increases there came, of course, increases in employment and wages. In the mining and manufacture of minerals in Germany the increase in the number of workpeople represented 50 per cent., and the increase in wages, per capita, 28 per cent. I do not

contend that the whole of this progress has been due to syndication and export bounties, but I do insist that without organisation the progress would not have been so substantial.

Recently, however, with a vigorous home demand taxing the uttermost resources of Germany's furnaces and mills, the need for export bounties and "dumping" has ceased—for a time. But we must not assume that German rivalry has ceased forever, or that it will ever cease for any great length of time. More and more capital is being invested in Germany's iron and steel trades; plants are being extended and equipment improved; large firms are amalgamating for the promotion of economy in production; the Steel Syndicate and its subsidiary organisations have taken a new lease of life; on every hand consolidation of interests is taking place, economies are being effected, and productive capacity is being increased. Should the home demands of our contemporaries decline—as, according to some reports, they are declining—or should their production again largely exceed their consumption, it is possible that the export-bounty system will be re-introduced, and that we may again be involved in a severe struggle. I do not think there is any cause for alarm on this score, but I urge that there is need imperative to strengthen our position in every way possible. And in nothing is there greater strength than in intelligent organisation.

Not less important than German competition is the question of American iron and steel trade prospects. Here we have to consider factors and circumstances much more uncertain than in the case of Germany, for industrial combination in America is unstable in character and inconsistent in policy—at any rate, it has been so hitherto, for the whole history of the American iron industry is a succession of "booms" and panics. Possibly, with improved organisation, the fluctuations will not be nearly so pronounced in the future as in the past—indeed, I believe that alike in Britain, in Germany, and in America, the future development of industrialism in general will be more steady.

The methods of industrial organisation usually adopted in America differ materially from those of Germany. While the Americans aim at one huge corporation, in the form of a limited liability company, the Germans are content to form what may be termed a manufacturers' union, or association. The United States Steel Corporation, formed in the Spring of 1901, has had a somewhat chequered career. It tried to absorb all the steel companies of any importance in America, and to regulate every process of production and method of dis-

tribution from mining the iron ore to fixing the price and effecting the sale of the finished product. For some of the iron and steel producing concerns it was obliged to pay big prices, and thus, from the first, the Trust was over-capitalized. And it failed in its primary object—it failed to obtain full control of the American iron trade, and just about one-half of the iron and steel production of the country remained independent.

From the commencement a keen struggle was waged between the Trust and the independent producers. The struggle is not yet ended. When the Trust was inaugurated prices were between 60 and 80 per cent higher than those prevailing in 1897, a year of marked depression, and although the tendency was distinctly towards still higher prices the Trust accepted orders at the then existing figures. The immediate result was that the Corporation mills became booked for many months, and those who needed delivery within any reasonable time were obliged to deal with the independent producers and pay bigger prices. Then followed a period of reaction. Demand relaxed, and delivery not being urgent, the independent producers had, perforce, to drop their prices. At this stage the Trust, having refused to put up prices to the extreme limit on a rising market, declined to follow the course of the falling market. Of course, custom went to the cheapest makers, the Trust got few orders, and was driven into a tight corner. Production was curtailed, extensions arrested, depression prevailed, and there was much dissatisfaction among shareholders who had bought at high premiums.

It has been argued that the cry of over-capitalization in connection with the Steel Trust was exaggerated; that it was fallacious to estimate the capital of any American concern by adding preference and common stock together; and that the common stock merely represented so much goodwill entitling the holders to dividends in good years. But the fact remains that this common stock was, and is now, the subject of much speculation. However, despite many difficulties, and despite many predictions of failure, the directors have managed to place the Trust on what appears to be a solid foundation. Plants are working up to the full limits of their capacity, positively enormous extensions are being made, and most of the known available deposits of high-grade ore in the country have been acquired. The American Trust, like the German Syndicate, seems therefore, to be destined to exercise in the future a huge influence, not only in its own country, but in the iron markets of the world. Hitherto American and German competition in iron and steel—syndicated and bounty-fed

competition—has been keen enough; in the future it may possibly be even more keen and relentless, because better organised and more skilfully conducted. In these circumstances it is well, therefore, that British manufacturers are displaying a stronger tendency than usual in the direction of combination for the protection of their rights and the development of their industry. Far better meet combined effort by combined effort, far better organise our methods, improve our policy, cheapen and specialise production, and adopt the co-operative principle in sale and transit, than go on the old-fashioned lines, clinging to ancient customs and antiquated ideas until we are elbowed out of the race.

Although in the past we have been easily relegated from the first to the third position as an iron- and steel-producing country, there is no justification for despair concerning the future. There is no need to discourage extensions and the investment of further capital in British steel industries because those of Germany and America have made greater headway in recent years than our own. Our rivals' progress is not due to the enjoyment of some great monopoly in Nature's bounties or in human skill, but is due to the fact that, having adopted and improved upon our best methods, they have wisely discarded some of our worst ones. We have not been beaten through lack of materials, or men, or money, but through lack of organisation. The idea that this country is played out, or about to be played out, must be dispelled. The growth of international competition, the progress of other nations, should have no terrors for us, but should simply spur us on to improvement, and to a wise organisation and development of our resources.

It is possible that at no very distant date Britain's rivals may have some surplus products which they may seek to "dump" upon her markets, but it is hardly likely that they will ever "dump" below cost price for any great length of time. The last "dumping" of cheap steel was, to a certain extent, a confession of weakness on the part of the "dumpers." Our rivals are now in a stronger position, financially, than they were then. We, too, are in a better position now than then, and, whatever may be the strength of evidence of an approaching collapse of the world's iron "boom," there is just as much evidence that, before current contracts are fulfilled, there will be a renewal of the pressure; and there is no reason why we should not hold our own, whatever may take place. One fact stands out clearly: there is no sign of permanent abatement in the world's demand for iron goods. Steel is being put to an ever-increasing number of new

purposes. There is no reason why we should not obtain an adequate share of this growing trade in iron and steel, for despite all that is said about the wonderful natural resources, and about the great enterprise and superlative skill, of our rivals, we in Great Britain can today profitably produce pig iron—the foundation of our steel and engineering trades—just as we can build ships, at a cost below that of other countries. That is the cardinal point, the supreme fact, in the issues involved, and should serve to inspire confidence in Britain's industrial future.

We have coal in abundance, and of good quality; we are not without vast and valuable deposits of iron ore close by our coalfields; we have ample foreign supplies of the richest ore within the easiest possible distance by sea; we have coal, ore, furnaces, and ships practically side by side, while our rivals' raw materials and shipping ports are widely separated; alike in natural resources and in geographical situation we possess some great—indeed, we possess some absolutely unique—advantages; and we have a wealth of capital and a plethora of skilful, efficient, and willing labour; but, to develop and utilise to the best and fullest extent our resources we need intelligent organisation.

It is not a valid argument to say that because trusts, syndicates, and combines in the past, or in other countries have made mistakes and abused their powers, therefore, organisation should not be effected, and cannot be perfected, among our manufacturers. In industrial unity there is commercial strength; and in commercial strength, national prestige and economic welfare. Industrial combination need not clash with public well-being, for, guided by the experiences of our contemporaries, we can avoid their errors, and guard against encroachment upon popular liberties.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By Charles U. Carpenter.

IX. THE UPBUILDING OF A SELLING ORGANIZATION.

Mr. Carpenter's series began in January, and the eight articles heretofore presented discussed, first, the general methods of examining into the condition of any manufacturing business so as to discover the existence of waste and loss and to determine the "sticking points"; second, the nature and the working of the "committee system" of factory administration; third, the reorganization of the designing and drafting departments; fourth, the great importance and value of the tool-room as a source and spring of profitable methods; fifth, the general conditions necessary for manufacturing at minimum cost; sixth, methods for fixing standard times for manufacturing operations; seventh, minimizing the time of assembling; eighth, stimulating production by wage, stock, and cost systems.—THE EDITORS.

IN an article as brief as this must be, it is, of course, out of the question to discuss at all fully the broad general question of methods of selling. Again, each business has its own peculiarities which make it necessary to apply special methods. At the same time, much can be said on that question of tremendous importance—the upbuilding of a highly trained, efficient selling force—that will be applicable to a business of any character. Different methods of making different manufactured goods make necessary some change in the plans, but in almost every case the fundamental elements are the same.

Methods of selling manufactured goods may broadly be divided into four divisions:—

First, where the goods are sold direct to the consumer by selling representatives of the manufacturing concern itself. This may be either through the company branch houses, or commission or salaried men, all of whom are employed and paid by the company. In this case, while considerable working capital is tied up and the stock of goods must be heavy, at the same time the selling division is directly under the control of the management and the territories themselves secure a company representation possible in no other way.

Second, selling to exclusive agencies, who themselves employ salesmen to deal direct with the consumer. This plan has much merit, although it is often difficult to devise plans whereby the agencies themselves may be forced to cover their territories and to develop an efficient selling department. It is also important to

notice here that in such cases the manufacturing company very often does not come into close contact with the individual members of the selling division of such agencies, and thus their methods are not properly impressed upon the men. A connecting bond between such agency salesmen and the manufacturing concern is of great importance. This becomes especially so in cases of sudden terminations of contract, etc.

Third, selling to jobbers. This plan is susceptible of such variety that it hardly needs consideration. Close connection between the jobber and the manufacturing company is very necessary. Constant and skilful attention must be paid him in order to secure adequate and permanent representation.

Fourth, direct advertising, selling by catalogues, etc. A discussion of this method of marketing product need not be considered here.

Whatever the business, whatever the method of selling, the importance of a highly trained efficient selling division stands out paramount. In developing a selling force, we must consider:

1. Training of salesmen.
2. Training of sales managers.
3. Developing of a proper system, whereby both salesman and sales manager can be properly checked up—the former, to ascertain if he is properly covering his territory, and getting his full quota of business, securing proper prices and terms, and keeping his old and new customers satisfied; the latter, to see if he has the proper grade of salesmen employed, proper control over them, proper methods of training them; also to note if he is securing an adequate volume of business at such prices and with such economy in operating expenses as to guarantee a sufficient profit.

Training of Salesmen.

Singularly enough, the majority of concerns today spend tens of thousands of dollars in advertising and in forcing the attention of the public upon their goods—in "creating the demand"—and yet they fail to train their sales employees—the men and women upon whom they must absolutely and finally depend as "closers"—so that they may know the "talking points" of their goods, the best methods of presenting their arguments, and the surest methods of finally "clinching the order." The unknowing sales manager often dismisses the arguments in favor of training of the salesmen with the trite remark "salesmen are born, not made." A mischievous belief! Granted that some men are by nature better fitted for selling than

others, those men are only too few. Training would surely improve their efficiency. Unfortunately, however, we manufacturers who market our own goods can find but very few of these "born salesmen," and are obliged to rely upon the "average salesman" for the most of our business getting. Such being the fact, it must be apparent that the average selling division needs badly a scientific and systematic method of training, in order that the large proportion of "average salesmen" may be brought to as high a degree of efficiency as possible. Nor does the advantage to be reaped stop simply with the training of the employees in selling. The meetings which this system calls for, if managed aright, are sure to prove of immense benefit in arousing a healthy and stimulating enthusiasm in the employees affected. An honest desire and intent on the part of these salesmen to "put in the best licks for the House" gives an impulse to their activities that nothing else can supply. This feeling can be instilled into them by a skillful, tactful sales manager. Do not forget that a sullen, listless, or disloyal member of your selling force affects your profits immediately. If you have many such, your department is costly and inefficient. The effect of your thousands spent on advertising is nullified by such conditions. On the other hand, a highly trained, loyal, interested and active selling force is one of the most valuable assets a firm can possess. That such a selling organization can be developed, even from one of a peculiar degree of inefficiency, has been proven by a long personal experience in several lines of business and very close observation of the results obtained in other modern business concerns.

John H. Patterson, the brilliant president of the National Cash Register Company of Dayton, Ohio, was the first business man to grasp the possibilities that lie in the training of the salesman. Through his genius, his company has developed probably the greatest and most efficient selling organization in the business world today. His example has been followed in the manufacturing business by such concerns as the Burroughs Adding Machine Company and the Herring-Hall-Marvin Safe Company, with decided success. Work of this character has been successfully applied to "Hapgoods," the firm doing a large employment business. Indeed, its essential principles can be adapted to the conditions of a business of any character in which the marketing of goods plays a large part.

Development of a Selling System.

While each business requires special study and special methods, the general plans of the "Science of a Selling System" can be clearly

pointed out so that they may be adapted. The two essential features of this system are "Salesmen's Demonstration Meetings" and "Salesmen's Training Department." While the "Salesmen's Training Department" is in fact the more important feature, I place the "Salesmen's Demonstration Meetings" first, because the training department is, nine times out of ten, the outgrowth of the demonstration meetings. The logical beginning of this system is with these meetings, because the points to be used in the training department are invariably secured from the discussions arising in these meetings. Again, these meetings serve as a gradual introduction for the later training department, and so accustom the selling force to the methods themselves that there arises but little opposition to the training department when it is first proposed. Each salesman, too, feels that he has had some part in the development of the training department, inasmuch as his own arguments are often used, and so thorough support can be elicited in place of the violent opposition that may be expected if any arbitrary methods are used. Woe betide the sales manager and the sales system if he starts at the "other end of the line," and attempts to force these methods upon his selling department before the members are ready for it.

Salesmen's Weekly Demonstration Meetings.

The points that will be brought out in regard to these meetings need no elaboration, as their merit is self-evident.

First, a time for these meetings must be set and constant attendance insisted upon. The sales manager must invariably be present and take part in discussions of all matters of importance. If possible, some higher official should be present once a month, in order to inject a new interest and new quality of enthusiasm into the salesmen. It will stir up both salesmen and sales manager tremendously if they are compelled to exhibit before someone high in authority.

Second, it must be kept in mind that these meetings are for the training of the salesmen (and incidentally the manager) and helping them over their difficulties, for arousing interest and enthusiasm, for giving the salesmen a chance to "blow off steam" on any trouble they may have that is affecting their efficiency, and for securing from them suggestions for the improvement of the business. A sample weekly programme is given on the next page.

Keeping in mind the main objects of this sales system—the creation of interest and enthusiasm and the training of salesmen—an examination of the succeeding suggested programme leaves an explanation almost superfluous.

PROGRAMME OF SALESMEN'S DEMONSTRATION MEETING.

1. Announcements. By Sales Manager.
2. Description of new products and fields they are designed to fill. By Sales Manager. (Suggestions and criticisms from salesmen requested.)
3. Demonstration of salesmanship. By Salesman—J. H. Smith.
   By Customer—G. R. Brown (Salesman).
   Censors—R. Fowler, H. White.
   (a) Selling the product to the customer whose business is carefully selected and who desires a good article.
   or (b) Selling customer asking for low priced article, a higher priced and more profitable product.
   or (c) Selling second hand product to customer.
   or (d) Selling customer asking for second hand product a new product.
   or (e) Selling customer new product, taking old product in exchange, at profitable allowance figure.
   or (f) Selling customer against strong competition, another salesman entering the demonstration as competitor's salesman.

NOTE: These demonstrations may be varied by having the same points illustrated as "Company-office Sales," where all stock and other paraphernalia are present, or as sales at the customer's office, where the salesman must depend upon illustrations, samples and catalogs.

4. Discussion of demonstration, first, by the appointed censors, Fowler and White, and second, by each salesman personally.
5. Discussion of week's business; why individual salesmen have not made their quota of sales and difficulties met by salesmen, from blackboard individual-sales record and from individual-sales reports.
6. A talk by the sales manager or some high-grade salesman on general important points of salesmanship, such as:
   Investigation of prospective customer's business and his methods.
   The proper "lining up" of selling arguments so that the "selling climax" may come at the right time.
   Methods of introduction, or "the approach."
   Methods of getting the prospective customer's attention and making demonstrating arguments.
   Methods of using closing arguments and "getting the signature to the order."
   Ways to meet certain arguments and objections of prospective customer.
   Ways to meet competitor's claims and arguments.
   Methods of cultivating a territory.
   Importance of "satisfied user."
   Importance of "knowledge of the business."
   Advantages to be gained by paying close attention to such seemingly small points as tact, dress, industry, perseverance, talking too fast or too much, answering customer's questions quickly, and a multitude of similar matters, perfection in which is so important.
7. Discussion of different competitors' products, their talking points and how to controvert them, their defects and how to prove them.
8. Suggestions and complaints.
9. General subjects such as advertising, etc.

In making announcements and describing new products, much can be done to create a lively interest in the company's affairs on the part of the salesman. A frank and full discussion of new products or proposed new designs will often prevent serious mistakes and will almost invariably result in suggestions that will make the product more marketable.

The suggested variations of "Demonstrations of Salesmanship" are also self-explanatory. Note carefully the appointment of censors. It is also especially desirable to hear comments upon demonstrations from each salesman. If the sales manager handles matters right so that the salesmen enter into this programme in a proper spirit, there need be no fear of salesmen becoming angry over fair criticisms. The "customer" can be selected from the sales office. He must be given to understand that he is not to aid the salesman in any manner, direct or indirect, and that he should bring up all the arguments and objections against buying that he himself has learned from his own customers. In a business where the product covers a broad field, embracing a number of widely different kinds of business, where a discussion of the business system enters into the sales, the "customer" and the character of the business can be selected so that in the course of a short time the demonstrations will cover the entire field and a full line of argument be brought out for each line of business. The character of the business and the conditions surrounding it should be thoroughly understood before beginning. Often a salesman who has had a particularly hard nut to crack will suggest the conditions and himself act the part of customer against a good salesman, in the hope of either "stumping him" or getting some good pointers. Especial attention may well be given to methods of convincing a customer that he should purchase a higher priced and more profitable product. Inasmuch as the selling expense remains the same, or very nearly so, an effective method of accomplishing this will result in a much larger proportion of profit. The most modern concerns pay a great deal of attention to this point and have developed a highly scientific and effective method for accomplishing it. This applies also to a business in which exchanges for old products enters into a large proportion of the sales. This is often a puzzling feature, and unless thoroughly understood results in large hidden losses.

Great interest can be aroused by the introduction of a salesman representing a strong competitor, who is supposed to do his best. Such exhibitions are not only highly instructive, but also inspire salesmen with a confidence in their own goods.

It is important that two demonstrations be often given, one conducted by an old and skilful salesman and one by a newer member of the selling force. This not only aids greatly in the education of the newer salesman, but often acts as a great spur on the older man not to be outdone by the newer ones. In conducting these demonstrations care must be used to see that no slipshod methods be allowed to creep in. The "sales" must be conducted with all the dignity and formality of a real transaction from the beginning, in order that the best form of "approach" or introduction of the subject may be observed.

A better method of instilling selling confidence into a man is hard to devise. After he has had to appear several times before a body of his selling companions and his superior officers he gains confidence rapidly and his attacks of "nerves" are things of the past. Such methods quickly develop the "quitter," for his improvement or elimination from the organization. They certainly show up the "dead wood" quickly.

The talks by sales manager or high-grade salesman upon general selling points, as noted under programme item 6, will prove of great benefit to new salesmen. The points brought forth—taken by a stenographer—are of great value later when organizing a method of training. The items given embrace only a very few of the important topics that may be discussed, but are given to illustrate clearly the nature of the talk suggested.

Programme item 7. While it is not often advisable to instruct salesmen to talk against competitors' goods, I regard it as absolutely necessary that salesmen be thoroughly posted on the character of competitors' products. Very often true statements of defects in such articles become necessary.

Suggestions and Complaints. This section deserves more consideration than can be given it at this point. Nothing is more vital to the progress of a company than the proper and conservative meeting of the actual market demands and the improvement of product so as, if possible, to keep ahead of the demand. No one knows the needs of the market or the advancement of competition as does the salesmen. A systematic plan to secure these suggestions from the body of salesmen will prove of very great value. The same may be said regarding complaints. Legitimate complaints should be "aired," and when the causes are ascertained prompt steps taken to rectify the troubles. Many a firm today prefers to shut its "business ears and eyes" and refuses to hear of troubles or to see perfectly obvious de-

fects which are continually having a disintegrating though hidden effect upon the business and organization.

The details of these meetings should be invariably taken down in shorthand. I have found it of great value to have sufficient copies of each meeting made to allow of their being distributed to the sales managers in all parts of the country.

It is important that the general sales manager consider it his particular duty to read carefully all minutes of these meetings and then to write to each local sales manager, commenting upon them, (in each case mentioning names of salesmen). The effect upon both manager and men is very beneficial.

The quality of the demonstration affords a very good proof of the calibre of the salesmen in each district and thus provides the clearest kind of an index to the quality of salesmen throughout all the points of the organization. Again, the salesmen are impelled to do their level best, knowing that the general sales manager will himself note the character of their work, even though he may be thousands of miles away. By such a simple means the influence and power of the general sales manager will be felt throughout the entire selling organization.

Salesmen's Training Department.

While much good can be derived from such weekly meetings, the progress of the men toward high-grade selling is necessarily slow. The influence toward rational methods is not constant enough. Again, constant individual attention should be given the new men at the beginning so that they may have the full benefit of such methods early in their selling career. Experience has shown that the only rational plan for developing salesmen rapidly and upbuilding a strong homogeneous selling department is to develop a strong training department for salesmen. This department should be independent of the influence of any local sales manager, but should be under the direct supervision of the general sales manager. It should be his "selling right hand." All local managers should be thoroughly trained in this department's methods so as to supplement its activity in their own local districts. All salesmen should be trained therein. Particular attention should be paid to the export trade agencies. Some firms establish training departments in the several foreign countries. Personally, I prefer to have even representatives of export agencies taught at the home office, so that they can not only get the best possible course of instruction but also may come under the direct strong influence of the home-office executives.

Scope of Training Department Work.

The first step (and often the most difficult) is to find the proper instructor. No greater mistake can be made than to attempt to use a cheap man. This work requires a man with the widest selling experience, coupled with great tact, patience, and teaching ability; a man whom the salesmen will respect for his ability. The outline of his work will demonstrate the necessity for having a man of sterling ability.

His first work will be to prepare a "Manual" for salesmen. This must contain

(a) Strong points on general salesmanship.
(b) A thorough and careful explanation of each product and its adaptation to all different lines of business.
(c) An exceedingly thorough explanation of the "talking points" or "selling arguments" of each product.
(d) An analysis of competitors' products and a comparison with the manufacturing company's product.
(e) A careful and scientific analysis of the best methods of introduction to a prospective customer so as to gain his attention and interest, this forming the "approach."
(f) Statements of the best methods of marshalling the talking points together so that a demonstration of the product's merits may be made to the customer—this forming the "demonstration and argument."
(g) A thorough and complete analysis of the best "closing arguments" and discussion of various ways to "get the order signed."
(h) A full list of the most common objections to making a purchase and ways of meeting these objections. After this plan is worked out, it will astonish many to note how simply the objections to purchasing on the part of prospective customers can be classified. It will also astonish the average sales manager to note how many different and excellent answers can be made to these objections by taking the answers to these by many managers and salesmen in different parts of the country. Whenever a salesman meets with some new form of rebuff, arguments to meet a new condition can quickly be secured by referring the question to the different managers for settlement in their weekly demonstration meetings.
(i) Much space may well be given to a thorough and logical explanation of best methods of raising a customer desiring a low-priced product to one of higher price, "Raising him up the line," as it is called. Really scientific work can be done along this line. Methods of handling second-hand sales and exchange sales should also be treated fully.

It will be noted that almost all of these invaluable data can be secured from the salesmen demonstration meeting reports.

After the selection of the instructor and preparation of the manual the balance of the work is largely routine.

First, each man—new or old—must be made to learn the manual "backward and forward." No halfway learning can be tolerated. He should then be thoroughly drilled in the "approach," "demonstration" and "closing" arguments under differing conditions along the lines noted in the Programme of Salesmen's Demonstration Meetings. He should be compelled to go through these in the regular demonstration meetings before the entire body of salesmen. This process will require from two to six weeks depending upon the man and the character of the business. He is then started out in a territory and carefully watched. It is well also at times to have him attempt to make a sale at the office so that his methods may be noted. After about a week of this experience the instructor should accompany him on his regular rounds so as to note his methods. Failure to attend to important points may thus be observed. The instructor should then illustrate the proper methods by taking the selling end himself with several prospective customers and closing the sales. After the salesman has been in his territory for a full month the instructor should spend another period with him.

After these men are distributed to different territories the local manager should give them the same attention.

The instructor should visit the several territories from time to time and note closely the salesmen's method of demonstration, both in the weekly salesmen's meeting and before their customers. A constant and close study of weekly sales reports, supplemented by the reports of the weekly demonstration meeting, will clearly indicate the weak spots needing attention.

The local managers should from time to time be called into the home office for conventions. These can be made exceedingly helpful to both company and managers. They are the backbone of the selling division and they cannot be watched, trained, inspired, and worked with too much. Not only must they be driven on the question of sales, but they must also be held responsible for economy in management.

The devising of proper sales systems is a subject in itself that cannot be fully treated here.

It is essential though that mention be made of the two forms from which spring many branches of the system, namely, the Salesman's Daily Reports. One covers sales made and gives the important details as to the customer and his business; the other covers cases of failure

and gives the reasons for non-success. The two forms are shown below:

SALESMAN'S DAILY REPORT OF SALES.

Name Customer .....Rating.....Date.....
Character of business and system used.....
What Sold.....Date Delivery.....
Higher Priced Machine needed.....(Date).....
Duplicate Machine needed.....(Date).....
Send advertising matter as follows: .....

SALESMAN'S DAILY REPORT OF FAILURE.

Name .....Rating.....Date.....
Character of business and system used.....
What needed?.....Why not sold?.....
.....Date to return.....
Send advertising matter as follows: .....

Couple these two reports with a comprehensive list of prospective customers, and you have the best foundation for a comprehensive and valuable sales system. Many other forms will naturally be added to these and many different methods used for properly tracing up "prospective customers" noted from these reports.

Through your prospective customer list, coupled with the salesman's daily reports, you can determine whether or not each man is properly covering his territory. If he is not, you can make him do so. The daily reports data enable you to classify these prospective customers so that you may be sure that they receive the proper attention at the proper time and the proper kind of advertising matter pending the next visit of the salesman. These reports are capable of indefinite amplification along lines which will be of immense benefit to the business, especially when used in connection with a sales system along the lines described. Such systems will admirably supplement the factory methods advocated in preceding papers, and will serve to unify the entire plan of organization, business, and method along such logical lines that there can be but one result—Progress!

A selling department built up along such lines is the best guarantee of high prices and good profits—a bulwark of strength against competition, and the strongest possible business foundation, especially in times of industrial depression.

APPLIED ELECTRO-METALLURGY UP TO THE END OF 1906.

By John B. C. Kershaw.

Mr. Kershaw's review began in the October number of THE ENGINEERING MAGAZINE. The first instalment of his article discussed the electro-metallurgical production of aluminum, refined bullion, calcium carbide, calcium, carborundum, copper, diamantine, and graphite. His concluding section deals with the electro-metallurgy of the ferro-alloys, iron and steel, lead, nickel, siloxicon, silicon, sodium, tin, and zinc.—THE EDITORS.

FERRO-ALLOYS.—The application of the electric furnace for producing alloys of iron with silicon, chromium, manganese, tungsten, and vanadium has developed into a large and important metallurgical industry. Since Moisson's early research work, the value of these alloys for the manufacture of special steels has been recognised by expert steel-makers in all countries. The manufacture of ferro-alloys is carried on at present chiefly in France and Switzerland, a cheaply developed water-power being essential for the commercial production of these compounds. In France, MM. Keller, Leleux & Cie. are producing ferro-silicon and ferro-chrome in large amounts at Livet and Kerrousse, while the Société Electro-metallurgique Française devote a portion of their power to the same manufactures, at La Praz and St. Michel. The largest works are, however, to be found in the Haute Savoie, on the borders of Switzerland, where the Société Electro-metallurgique Girod are utilizing 18,000 horse power for the production of a ferro-silicon, ferro-chromium, ferro-tungsten, and ferro-molybdenum, the aggregate output of the three works owned by this company being given by Dr. Hutton as 9,000 tons per annum, and the value as £360,000.

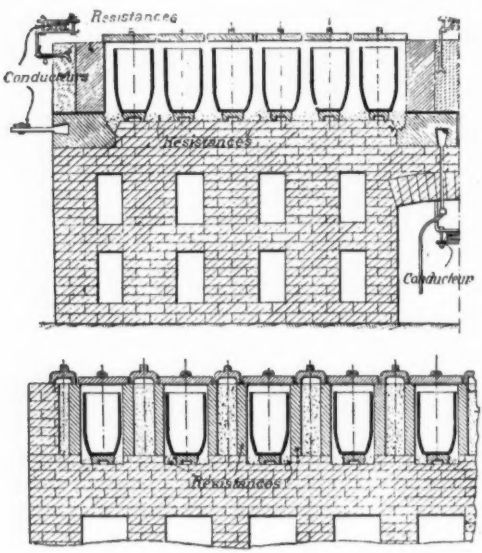
In Germany MM. Goldschmidt & Cie and MM. Krupp are using the aluminium reduction process, in place of the electric furnace, at Essen for producing ferro-alloys free from carbon.

In America the ferro-alloys industry is less developed, the Willson Company, with works at Kanawha Falls and at Holcombs Rock, Va., being the only producers of ferro-chromium; about 3,000 tons are produced in the two works. Rossi is, however, experimenting at Niagara Falls with electric-furnace methods of producing ferro-titanium and a new works has been erected during 1906 at Newmire,

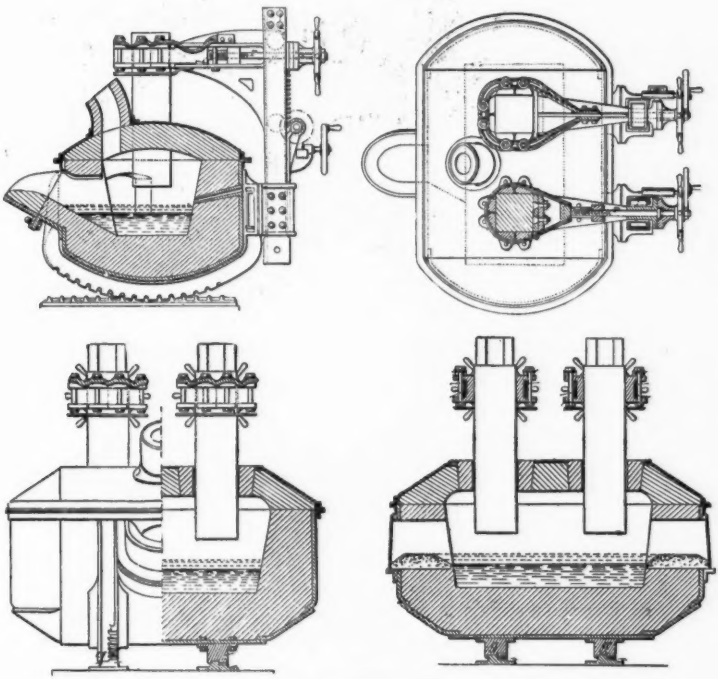
Colorado, by the Vanadium Alloys Co. of New York, for the manufacture of ferro-vanadium. Recent trials of ternary and quaternary steels, made with the addition of vanadium, have proved that these steels are specially suited to the demands made by motor-car work, and it is expected that in time the manufacture of vanadium steel may become a branch industry of considerable importance.

With regard to the use of ferro-alloys generally, ferro-silicon is employed as a deoxydizing agent, while the other alloys are employed for introducing the rarer metals into the steel, it having been found that a more homogeneous product is obtained when the metal is introduced into the molten steel in the form of an alloy than when it is introduced in the pure state. All the chrome-steel used for armour-plate manufacture is now made with the aid of ferro-chrome.

IRON AND STEEL.—The methods of producing iron and steel in the electric furnace have been developed chiefly by French electro-metallurgists, a large number of works in France having been rendered idle by the collapse of the boom in the calcium-carbide industry in 1899-1900, and new applications being required for the water-power and electric-furnace plant thus made available. The earliest trials of the electric furnace for iron and steel production date from 1899, and since that year experimental work has been carried on continuously. During the last three years the new methods have attracted the attention of steel makers, and it is now generally recognised that certain of the methods and processes have attained a permanent footing in the iron and steel industry. The Heroult and Kjellin methods



VERTICAL SECTION OF A GIROUD ELECTRIC FURNACE FOR CRUCIBLES INDIVIDUALLY HEATED.

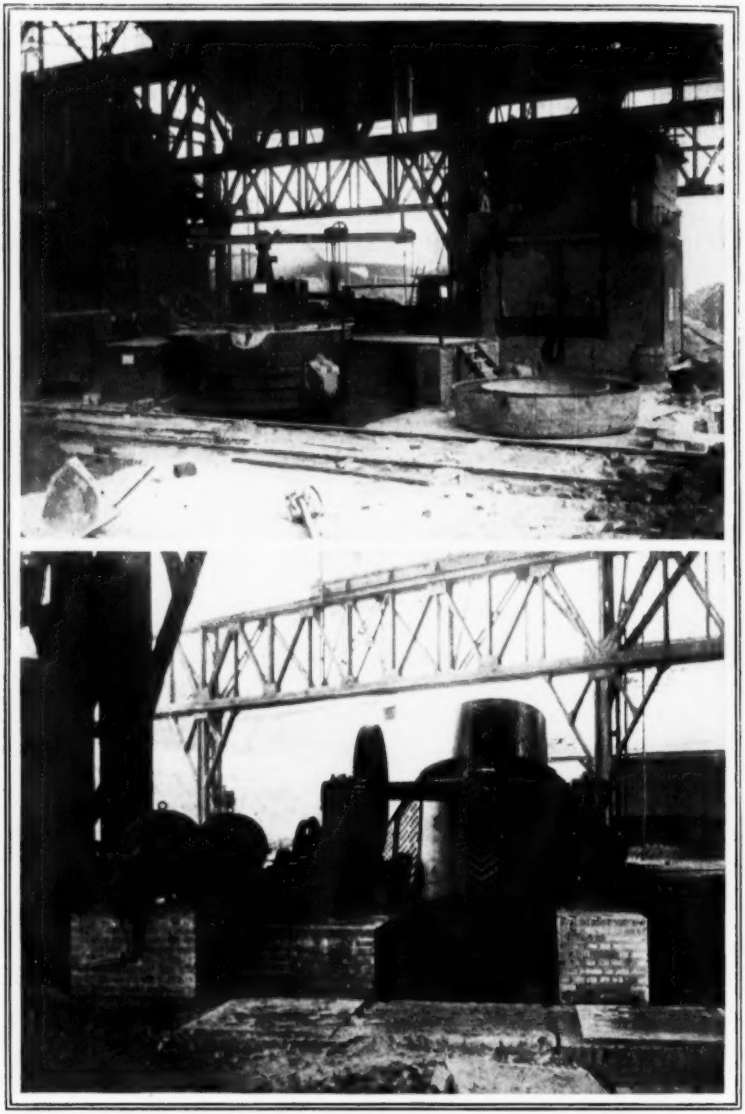


LONGITUDINAL AND TRANSVERSE SECTIONS OF HÉROULT CRUCIBLE FURNACE.

of steel refining by aid of electric heat have shewn the most striking development, and a large number of works in Europe and America are using these methods with satisfactory results.

The Heroult steel-refining furnace is of the crucible type, and the heating is initially effected by means of the electric arc, which forms between the surface of the slagging materials covering the metal and the two massive carbon electrodes which are suspended above it. The slag when molten is used for resistance heating, the carbons being lowered until they touch it. The impurities of the iron are removed by renewing the slag from time to time. The refining operation thus becomes a "washing out" of the impurities of the iron, by treatment with suitable slags. When purified, "carburite" in requisite amount is added, and the crucible is tipped.

Heroult claims that with this furnace iron or steel of any degree of impurity can be refined, and that from the purified metal, a steel



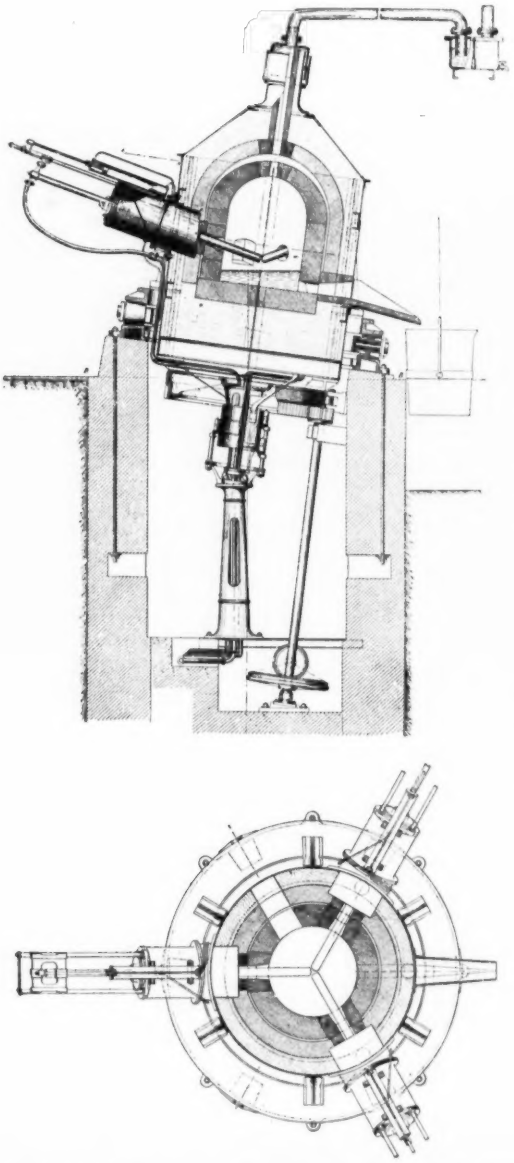
KJELLIN 1,000 HORSE-POWER ELECTRIC FURNACE. TOP AND BOTTOM VIEWS.
The lower showing the motors and gearing by which the furnace is tipped for pouring.

of any desired composition can be produced by the addition of the necessary amount of "carburite" and other ferro-alloys.

The Heroult furnace is now in operation at La Praz and Froges in France, at Kortfors in Norway, at Remscheid in Germany, and at Syracuse, New York. The Remscheid plant has been in operation since February 1906 and is on a smaller scale than the Syracuse plant.

A NEAR VIEW OF THE TOP OF A KJELLIN ELECTRIC FURNACE OF 1,000 HORSE-POWER.
The latest type, of which details have so far been kept secret.

The Kjellin furnace has been developed at Gysinge in Sweden, and differs materially from the Heroult furnace. In place of the use of direct current for combined arc and resistance heating, the Kjellin process utilizes induced currents, and the heating effect is obtained by the rapid changes in the magnetic state of the iron or steel which forms the secondary coil of the circuit. The Kjellin furnace is in reality a large transformer, in which an alternating current of low amperage, but high voltage, is transformed into an alternating current of large intensity but low pressure in the secondary coil of the apparatus. The metal is contained within an annular ring built up of refractory blocks round the primary coil of the furnace, and by varying the current in the primary, the heat developed in the secondary can be regulated as desired. The advantage of the Kjellin furnace

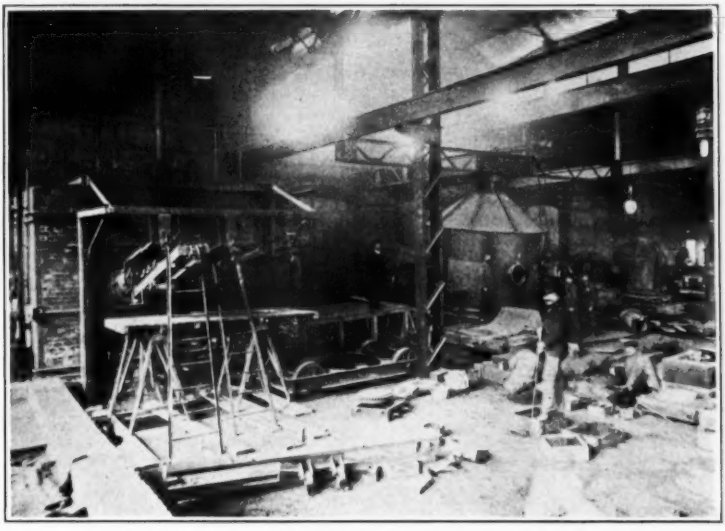


PLAN AND ELEVATION OF STASSANO REVOLVING FURNACE.

are the development of the heat just where it is wanted, *i. e.*, entirely within the metal, and consequent small wear and tear upon the structure and walls of the furnace, and secondly, the absence of impurities picked up from the electrodes used in all other methods of applying electric heat. The Kjellin process and furnace are being worked successfully at Gysinge in Sweden, at Gurtmellan in Switzerland, at Krupp's steel works in Germany, at Vicers steel works in England, and also at the Araya steel works in Spain, while in America a furnace patented by Colby but worked upon the same principle has been operated with successful results at Philadelphia.

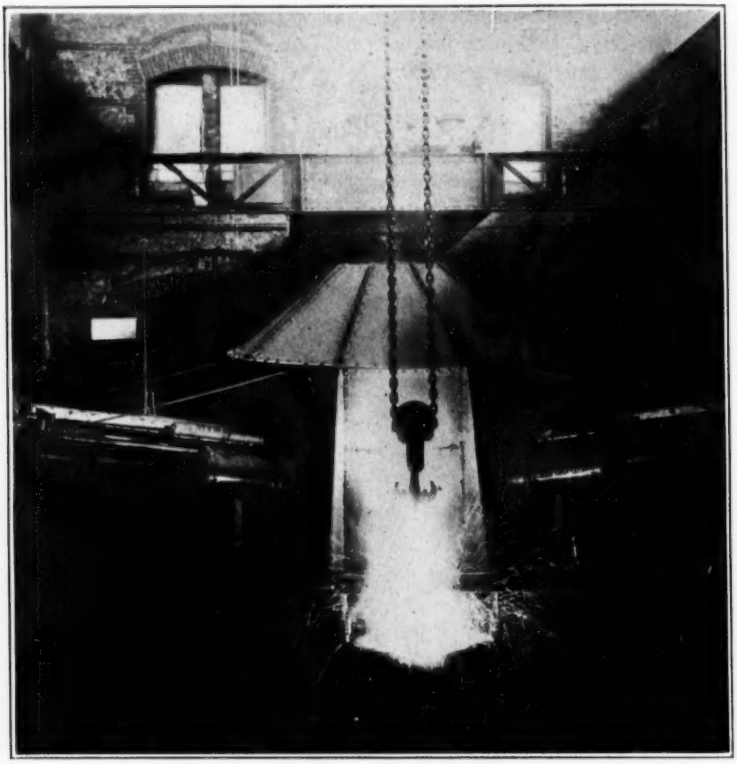
Three electric-furnace methods for the production of iron and steel direct from the ore have been tried upon a small industrial scale in Italy, France and Canada.

The first of these—the Stassano—has not achieved success, although large sums of money were expended upon the trials at Rome and Darfo in Northern Italy. An arc furnace of the rotary type was employed, and the ore was ground and briquetted with the lime and coke, before charging into the furnace. The costs of grinding and briquetting all the raw materials, and the difficulty of maintaining a durable lining to the furnace, were the principal causes of failure.



STASSANO 1,000 HORSE-POWER ELECTRIC FURNACE, FIXED TYPE.

The Keller furnace and process for the production of grey, mottled, and white pig iron from the ore, has been operated at Livet in France for several years, with moderate success. The furnaces are of 1000 horse-power and 308 horse-power capacity, of the two shaft type, with large carbon-block electrodes slung in chains in the centre of each shaft. The heat is obtained by combined arc and resistance heating. A canal connects the hearths of the two shafts, and when filled with molten iron this canal serves as the electrical connecting link between the two portions of the furnace. The ore is crushed roughly, to a size of 2 inches, and is charged with the lime and coke into each shaft of the furnace. The electric power required per short ton of pig iron produced at Livet averages 2,300 kilowatt hours, and



POURING A 1,000 HORSE-POWER STASSANO REVOLVING FURNACE.

it is estimated that with power at $10.00 per electrical horse-power year, a ton of pig iron could be produced by the Keller furnace and process for $11.60. A furnace designed to produce 20 tons of grey iron castings per 24 hours has been erected at Livet, but I am not aware whether it is yet in work.

The third process and furnace are that of Heroult, and the most important trials have been conducted at Sault Sainte Marie, Canada, under the auspices of the Canadian Government. The furnace is a single-shaft furnace of most simple type. The smelting of the ore is carried out by combined arc and resistance heating, the raw materials being charged without grinding into the shaft of the furnace, in which hangs the heavy carbon-block electrode, while the sole plate primes the other electrode. The experiments with this furnace at

Sault Sainte Marie proved that magnetite and titaniferous iron sand could be smelted without difficulty and that charcoal could be substituted for coke, without briquetting. The electric power required per ton of iron was 1,541 kilowatt hours, or less than at Livet, but later trials of the same furnace at Sault Sainte Marie have shown that the larger power consumption is the more correct. The furnace has now been taken over by the Lake Superior Company financing the development of this new industrial centre, and 54 tons of nickel pig have been produced in it from the roasted pyrrhotite ore of the district. This attempt to found a new iron and steel centre in Canada may have most important results upon the development of countries which have iron-ore deposits, but no coal with which to smelt the native ores.

LEAD.—Several attempts to introduce electrolytic or electro-thermal methods for the refining of lead have been made in America, and one such process was worked for some time upon a large scale at Niagara Falls, but the company financing this venture ultimately ended in liquidation. At the present time the Betts refining process, in which lead bullion or raw lead is used as anode material, in a bath of lead fluo-silicate, is in operation at Trail, British Columbia, and at

TANK HOUSE AND MELTING ROOM, CONSOLIDATED MINING & SMELTING CO., TRAIL, B. C.

Capacity 80 tons of lead daily, by the Betts process.

Newcastle, England. The plant at Trail was enlarged in 1906, and consists of 240 vats, each 7 feet in length by 30 inches wide. When charged, each vat contains 20 anodes and 21 cathodes, and the capacity of the plant is stated to be 90 tons of refined lead per day. The separation of the lead from the copper, bismuth, and cadmium contained as impurities in the raw lead, is reported to be almost perfect. Betts has recently proposed to introduce electro-thermal methods for smelting the lead ores, but these proposals do not appear to have yet been submitted to practical trial.

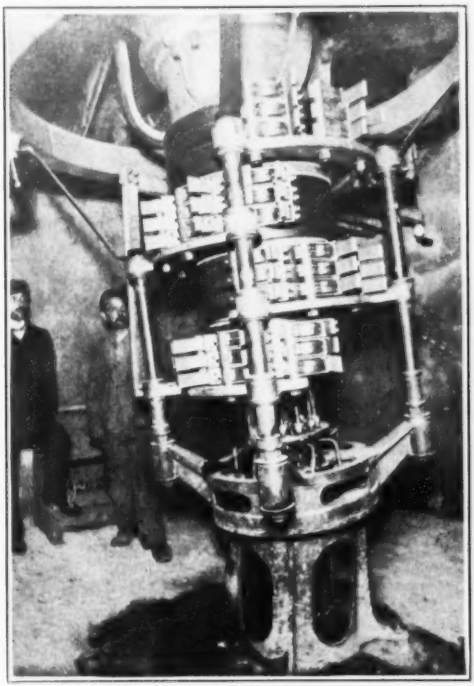
NICKEL.—Nickel is produced by electrolytic or wet methods, by three companies, and at Sault Sainte Marie, Canada, experimental trials have recently been carried out which show that ferro-nickel can be successfully extracted from the ores of the district by the Heroult electric smelting furnace. A permanent installation of the Heroult furnace at this place is therefore possible. As regards the electrolytic methods of extraction, the Hoepfner process is in use by the Allegemeine Elektrometallurgische Gesellschaft of Papenburg,

ELECTROLYTIC LEAD REFINERY OF THE CONSOLIDATED MINING & SMELTING CO., TRAIL, B. C.

Germany. The process depends upon the elctrolysis of mixed solutions of copper, calcium, and nickel chlorides, these being obtained by leaching the roasted nickel ore with a solution of calcium and cupric chlorides.

In America, the Orford Copper Co. have recently commenced to

produce electrolytic nickel, using as anode material for the vats slabs of nickel sulphide. These are obtained by operation of the "tops and bottoms" process for separating nickel and copper sulphides. The electrolyte is nickel-chloride solution, while thin sheets of pure nickel are used as cathodes. The electro-deposited nickel tests 99.5 per cent.



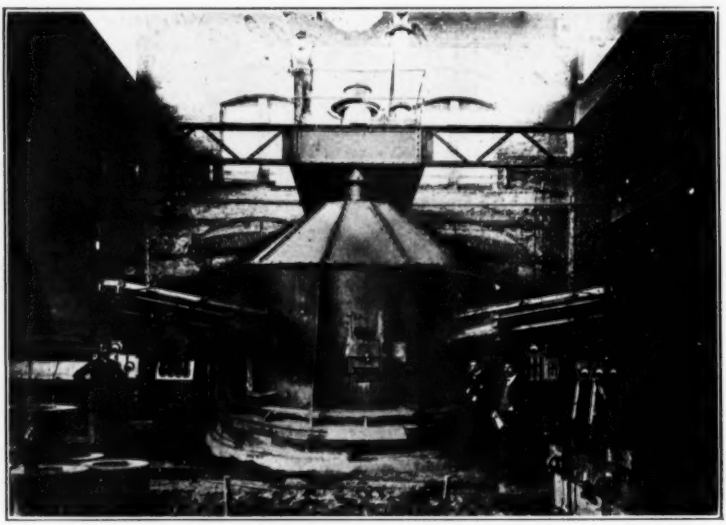
COLLECTORS AT THE BASE OF A STASSANO 1,000 HORSE-POWER ELECTRIC FURNACE.

A third electrolytic process in use at Sault Sainte Marie is stated to be the Hybinette process (United States patent No. 805,969 of 1905). The electrolyte in this process is a dilute solution of nickel sulphate, to which a small quantity of boric or phosphoric acid has been added. The anodes are made from a ferro-nickel-copper alloy. The cathodes are thin sheets of copper enclosd in porous bags, and held in wooden frames to prevent buckling. The flow of fresh electrolyte is directed into the bags which contain the cathodes, and by maintaining a higher level of liquid in these, the drift of copper ions, dissolved at the anode, towards the cathode compartment is stopped, and only pure nickel is deposited at the cathode. The electrolyte becomes continuously richer in copper and iron, and is regenerated by passing over slabs of nickel, or of a nickel-copper alloy. The copper is deposited and the nickel takes its place, while the iron is removed at a later stage, by oxidation. The solution then contains only nickel sulphate, and is ready for use again in the vats.

SILOXICON.—This is the name given to an electric-furnace product

made by Acheson at Niagara Falls, by heating carbon and silicon in a fine state of sub-division and well mixed, to a temperature slightly below that required to produce carborundum. The product is a highly refractory material, and a company has been floated in the United States for the manufacture of siloxicon crucibles, muffles, bricks, etc. The chief difficulty in the manufacture of siloxicon is the regulation of the temperature, since if this be raised too high (above 1,700 degrees C.) the oxygen escapes and carborundum is produced.

SILICON.—F. J. Tone has produced this metal in large amount at Niagara Falls, by heating sand with carbon in an electric furnace of the resistance type. It is essential that the raw materials be finely ground and well mixed, and that the temperature be carefully regulated to prevent formation of carbides. The metallic silicon must be drawn off as formed, the process being continuous, and the metal obtained bright and crystalline. Tone states that the metal may be used as a deoxidizer in the iron and steel industry, and as a substitute

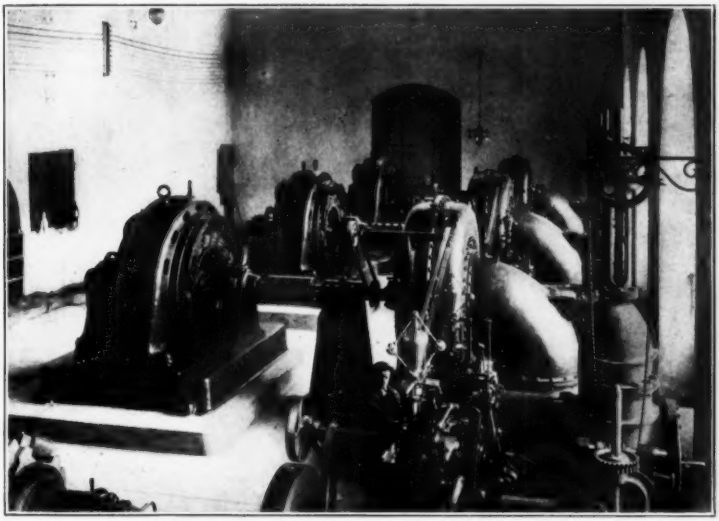


STASSANO 1,000 HORSE-POWER REVOLVING FURNACE.

for aluminium in the "thermit" mixture; but the demand for silicon for these and other purposes does not appear to have developed, and the difficulty at present is to find a market for the product.

SODIUM.—The production of this metal by the electrolysis of the

fused hydrate has grown in recent years into an important industry, and the older chemical method of manufacture has now been quite supplanted by the electrolytic method. The Castner cell and process are generally employed. Installations of this cell are now working in

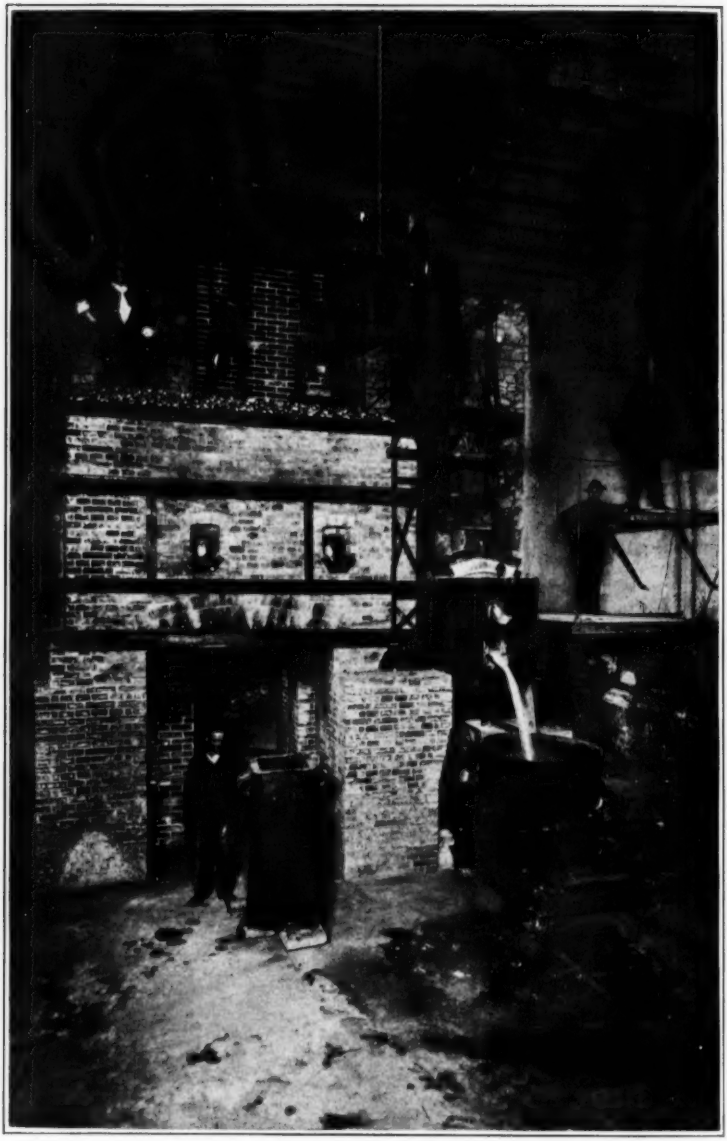


HIGH-TENSION GENERATORS, KELLER, LELEUX & CIE., LIVET.
Three three-phase 2,500-kilowatt alternators and two continuous-current units.

England, America, France, and Germany. The manufacture of metallic sodium in England is in the hands of the Castner-Kellner Alkali Co. The plant has recently been transferred from Weston Point to Wallsend-on-Tyne, where a new works has been erected, the power required being purchased from the Newcastle and District Electric Supply Co. at a very low rate.

Ashcroft has patented a cell and process recently by which sodium chloride can be substituted for the hydrate in this manufacture. This process is about to be tried upon an industrial scale in Norway Should the attempt succeed, the cost of metallic sodium which has already been reduced from 4s. to 1s. 8d. per kilogramme by the improvements in the Castner electrolytic process, will be still further reduced.

The sodium produced by the electrolytic method is largely employed for the manufacture of sodium cyanide, and of sodium peroxide. "Oxone" is the trade name given to fused sodium peroxide,



DOUBLE ELECTRIC FURNACE, WORKS OF KELLER, LELEUX & CIE., LIVET.

The metal is melted in an upper furnace and poured into a lower one, in which the operation is finished.

and this product is being advertised and sold in America for the generation of pure oxygen.

TIN.—Electrolytic or electro-thermal methods have not been applied with any success to the extraction or refining of tin, but in a branch industry—namely, "tin stripping"—they have become of considerable value and importance.

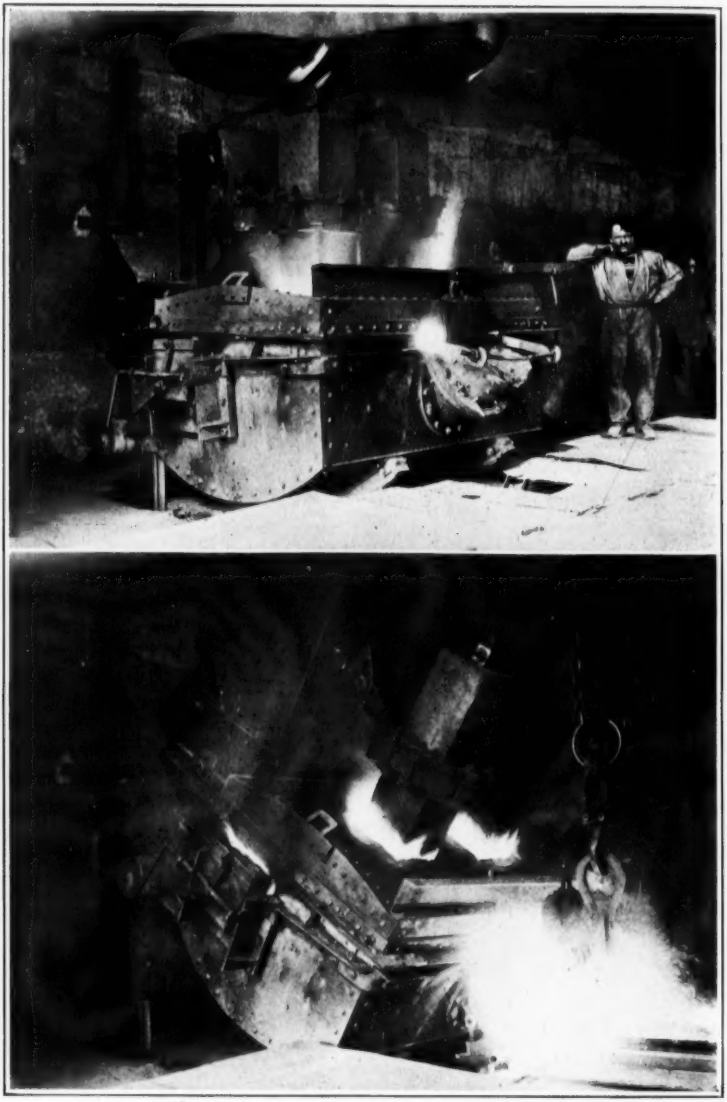
In the manufacture of cans, boxes and vessels of all kinds from tin plate, an immense amount of waste occurs with the cuttings, and the recovery of the tin from these has been carried out for some years by electrolysis. The process usually employed was first applied industrially by Goldschmidt at Essen in Germany, and consists in the use of the scrap and cuttings as anode material in a bath of sodium hydrate. Stannic-chloride solution has also been used as electrolyte in the Bergsoe process at Copenhagen. In the former case, only the tin is dissolved at the anode; in the latter case the iron is also attacked, and care is therefore required to prevent the solution of tin-chloride from becoming supersaturated with the iron salt. The chief development of the electrolytic tin-stripping industry has occurred in Germany, but similar factories have also been erected and carried on in Denmark, Austria, England, and America. The chief difficulty in working the process has been to maintain an adequate supply of tin-scrap and cuttings, and some of the works have had to close down from this cause. Purely chemical methods of stripping by means of chlorine gas are also now coming into favour.

This will still further accentuate the difficulty of supplies, since the electrolytic alkali and bleach works will enter the market as purchasers of the tin scrap and cuttings. By this method of stripping, stannic chloride is produced, and not metallic tin. The manufacture of "tin-salts" has already been taken up by some of the electrolytic alkali works in Europe and America.

ZINC.—The attempts to apply electrolytic and electro-thermal methods in the zinc industry have met with only partial success, and the greater proportion of the zinc found in commerce is still produced by the old metallurgical method of distillation.

The coating of iron articles with a protective deposit of zinc is, however, carried on in a large number of works by the electrolytic or wet method, a solution of zinc sulphate being generally employed as electrolyte, with lead anodes. "Electro-galvanizing" as it is called, is then an important branch industry.

As regards the extraction of zinc from its ores, the Hoepfner process is in operation at Winnington in Cheshire and at Hruschau in



HÉROULT ELECTRIC TIPPING FURNACE. THE LOWER VIEW SHOWS THE POURING OF THE CHARGE.

Austria. By this process, zinc chloride is obtained from the waste liquors of the ammonia-soda process, and is electrolysed in order to obtain metallic zinc and chlorine gas.

A zinc-ore chlorination process, patented by Swinburne and Ashcroft, is operated at Weston Point, England, by the Castner Kellner Alkali Co. Zinc-sulphide ores are treated with hot chlorine gas, and the corresponding chlorides are obtained, but the zinc chloride is sold as such, and is not subjected to electrolysis as described in the patents covering this process.

Electrothermal methods of treating raw zinc and zinc ores are being experimented with by de Lavel and by Ferraris, in Sweden and Italy. The de Lavel furnace has already produced some hundreds of tons of pure zinc from spelter, but I understand that it has not yet been applied with success to the reduction of the ore. At Monte-Poni in Italy, Ferraris is carrying out similar trials with an electric furnace, and has estimated the cost of the process at 40 lire per ton of calamine. In a recent letter he stated, however, that the method has not yet reached the industrial stage of its development.

PRACTICAL EXPERIENCE WITH EXHAUST-STEAM TURBINES.

By Dr. Alfred Gradenwitz.

In these days of discord and strife over the applicability of the steam turbine to marine propulsion, it is refreshing to turn to a consideration of one of the minor fields of application of this type of prime mover, in which there can be no doubt of its utility and value. Dr. Gradenwitz's article, with its numerous illustrations taken from the operating records of actual plants, shows clearly the economies which may be effected by the installation of low-pressure turbines for the utilization of exhaust steam, and the advantages which this system possesses, particularly in mining and steel-works plants, in a great variety of applications.—THE EDITORS.

THE greatest drawbacks encountered in using the exhaust steam from factories and mines for the production of energy have been the unsatisfactory utilisation of low-pressure steam as effected in reciprocating engines, and the intermittent operation of most steam-consuming machines in iron works and mines, which called for the arrangement of some steam accumulator. The secondary engine, furthermore, had to be made entirely independent of the primary engine.

M. A. Rateau of Paris, in connection with his work in turbine construction, has evolved a type of steam turbine which is especially adapted to work with high efficiencies, and which accordingly may be operated by the use of exhaust steam.

That engines designed on the turbine principle are alone suitable for utilising exhaust steam is shown in a lecture recently delivered by Rateau at Brussels, the proof being found in theoretical considerations based on the entropy diagram. A reciprocating engine worked with an initial pressure approaching that of atmosphere, in order conveniently to utilise the whole of the drop in pressure produced by a condensing plant, would in fact require dimensions so enormous as to make its space requirements, weight and cost of installation in proportion to output quite inadmissible. If, on the other hand, a turbine be used, low-pressure steam could very well be employed, the vacuum given by even the most perfect condensers being utilised to the best advantage. Owing to the considerable issuing speed of the steam and the enormous resulting capacity, it would in fact be quite feasible to design a turbine utilising a low-pressure

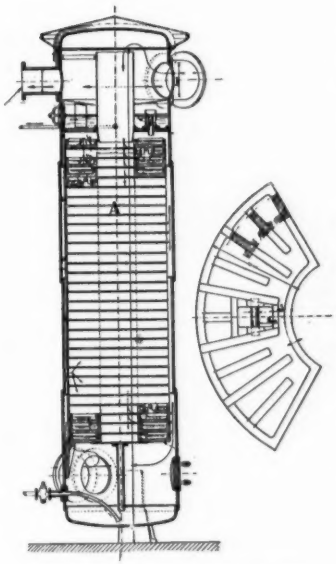


FIG. 1. IRON ACCUMULATOR.

steam flow of several thousands and even tens of thousands of kilogrammes per hour, while remaining within rather moderate dimensions as regards the size of the engine.

As the expansion of steam at low pressure is utilised so satisfactorily in turbines, special interest attaches to the provision of improved condensing plants, ensuring an excellent vacuum, which in the case of a reciprocating engine would be of no avail. The efficiency of turbines in fact is the more satisfactory as the steam pressure is lower, because of the reduction of losses due to the friction of the rotating discs in the steam, and to leakage between the rotating and stationary parts, which two losses are practically proportional to the specific weight of the fluid medium and accordingly are the smaller as the specific volume of the latter is greater.

By the aid of the same diagram of entropy, Rateau then shows that a combination consisting of a reciprocating steam engine (for the high-pressure stage) and a steam turbine (for the low-pressure stage) would be the best means of ensuring an expansion of the steam as perfect as possible. A similar combination, in conjunction with a suitable steam accumulator, would in fact allow of as high efficiency being obtained under average conditions as in the case of the most highly improved gas or petrol engines. This would accordingly afford the most desirable solution of the problem at issue.

As regards in the first place the steam accumulator which is indispensable for regulating the flow of steam issuing from the primary engine, Rateau first used an apparatus made up of cast-iron plates. This, according to Figure 1, comprises a vertical sheet-metal cylinder, containing in its interior a pile of annular cast-iron cups filled with water between which the steam is allowed to circulate. Intermittent steam currents coming from the primary engine through the upper

pipe are distributed to the cups by the central channel A, while the regularised steam current issues through the lower pipe towards the secondary low-pressure steam engine. The mass of the cast-iron cups and the liquid contained by the latter constitute a heat buffer by the action of which the steam is condensed and accumulated when it arrives abundantly, in order to be formed anew during the time of slackening or discontinuance in the flow of steam issuing from the primary engine. The variations in temperature required for condensing and regenerating the steam correspond to small fluctuations of pressure in the accumulator, the pressure rising when the apparatus is being replenished and falling when it is discharged according to the requirements of the turbine. The maximum fluctuations in temperature controlling the working of this accumulator are as an average 2 to 4 degrees C. and those in pressure 0.10 to 0.15 kilogramme per square centimetre (1.4 to 2.0 pounds per square inch). They may moreover be reduced at will by designing the apparatus of sufficient size. When the pressure in the interior of the accumulator rises above the figure allowed for the back pressure of the primary engine (0.15 to 0.25 kilogrammes per square centimetre), (2.1 to 3.4 pounds per square inch), the steam escapes through a valve controlled at will.

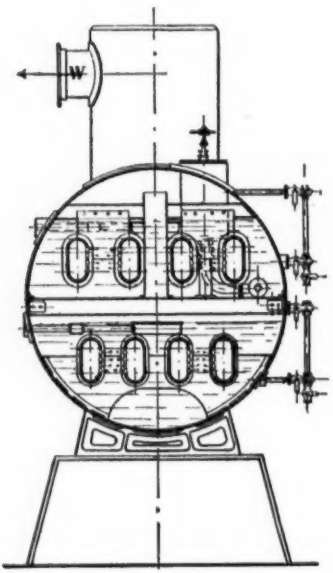


FIG. 2. WATER ACCUMULATOR.

Accumulators of the above type have been constructed for the Bruay mining plant, and the Poensgen and Donetz steel works. Owing, however, to their considerable cost of installation, Rateau subsequently designed another type of accumulator, consisting of the shell of old cylindrical boilers, inside of which some old rails were arranged. These accumulators, the cost of which was evidently reduced to a minimum, have been actually installed at several Spanish and English mines.

However, the best system of accumulator obviously would be a water accumulator, as

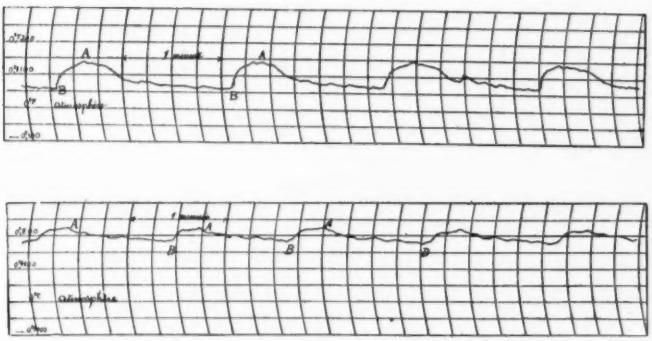


FIG. 3. MANOMETER RECORDS OF ACCUMULATOR PRESSURES.

water possesses a maximum heat capacity, while costing little or nothing. A difficulty encountered in this connection is the bad thermic conductivity of this liquid. In order therefore to impart a large amount of heat to a given mass of water, the latter should be given a very active circulation. The apparatus constructed by Rateau comprises a horizontal cylinder boiler containing water, which in the case represented in Figure 2 is divided into two compartments placed above one another. In the interior of the liquid are located big horizontal pipes of oval cross section, into which the steam is thrown, the walls of these pipes being perforated by a number of holes, so as to lead the steam without any shock to the intermediary spaces between the pipes. While the steam is arriving the water containing steam bubbles will rise in the intermediary spaces between the pipes and descend sideways. Circulation is so lively that the water particles, about every two seconds, come into contact with the steam, so that practically the whole mass of water takes an efficient part in the absorption and recuperation of heat. The accumulator is provided with discharge pipes ensuring an automatic regulation of the water level.

Graphical records—obtained by means of a recording manometer —of the results ensured by this type of accumulator (which is nearly exclusively employed at present) are given in Figure 3. The horizontal line O represents atmospheric pressure, and the interval between each two vertical curves corresponds to a duration of 15 seconds. The upper diagram of Figure 3 was obtained on the accumulator of the Béthune mines when this was fed only by the winding engine. The abscissa BA corresponds to a whole winding period, lasting about

10 seconds. During 15 seconds, from B to A, the winding engine throwing steam towards the accumulator, the pressure in the latter will rise to 0.11 kilogramme per square centimetre. From A the accumulator receives no further steam, while continually feeding the turbine, so that its pressure decreases until the winding engine in B starts for its next run, thus supplying it with further steam flows.

The lower figure shows the diagram recorded while the accumulator was fed simultaneously from the winding engine and other continually working machines. In this case variations of pressure in the accumulator are seen to be much smaller, not exceeding 0.05 kilogrammes per square centimetre instead of 0.10 kilogramme as before (0.7 pound per square inch instead of 1.4 pounds).

The mutual independence of the primary and secondary engines is ensured by fitting the accumulator with a self-acting valve, which discharges the steam from the primary engine while the turbine does not absorb any. The surplus of steam can be thrown into the atmosphere, but is preferably conveyed to the condenser, thus allowing the accumulator if desired to be worked at a pressure inferior to atmospheric pressure, so that the primary engine utilises a certain vacuum. In the case of a prolonged standstill in the primary engine, such as

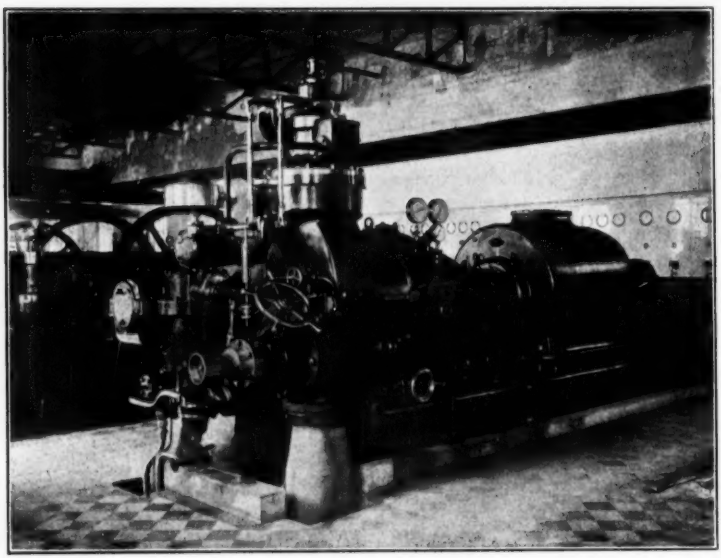


FIG. 4. TURBINE AT THE KLEIN RÖSSELN MINES.

FIG. 5. TURBINE OF THE ZOLLVEREIN MINES.

during the hours of meals of the workmen, the live steam from the generators can be drawn on so as to make up for any deficit in the output of the accumulator. For this purpose a self-acting steam expander is provided, which is opened as soon as the pressure in the accumulator falls below a given limit, adjusted for at will. In the place of one expander and a low-pressure steam turbine, a mixed set comprising a high-pressure turbine and low-pressure turbine will finally be found more advantageous, ensuring a far better utilisation of the steam in case the turbine has to be fed directly from the boiler.

The efficiency of low pressure turbines of the Rateau system is about 75 per cent of the energy theoretically available between the working pressures, in the case of units of about 1,000 horsepower. By means of certain improvements this figure may be raised to about 80 per cent.

The first plant fitted up on this system was installed in 1902 in pit 5 of the Bruay mines. This plant comprises a generating set consisting of a continuous-current turbo-dynamo of 250 to 300 kilowatts, and an accumulator consisting of four vertical sheet-iron reservoirs containing 40 tons of cast iron and about 4 tons of water. The energy produced by this set, outside of the lighting plant, serves to supply the several electric machines of the mine. Since the inauguration of the accumulator plant, the reciprocating engines which formerly were used in producing electric currents have been shut down, it being found more advantageous to allow the turbine to work even by night.

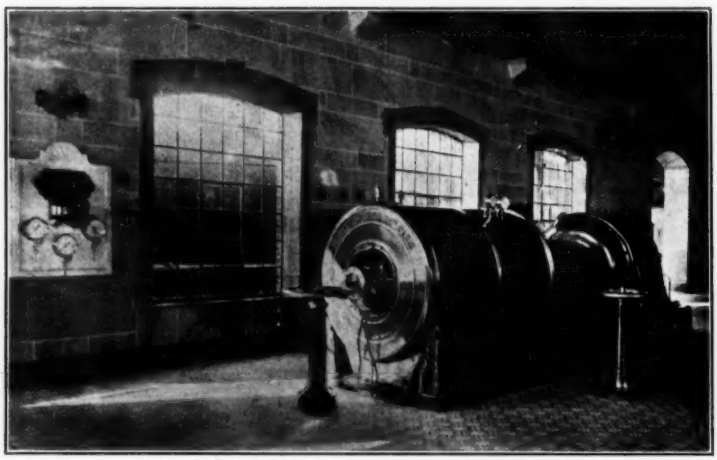


FIG. 6. TURBINE AT THE GELSENKIRCHEN MINES, ALMA SHAFT.

The first application of the Rateau system in England was made at the Hucknall-Torkard Collieries near Nottingham. This plant comprises a steam accumulator consisting of 50 tons of old rails, and a low-pressure turbine of the Rateau system. The latter is a 200 horse-power unit rotating at 3,000 revolutions, and is coupled to a rotary-current generator yielding current at 500 volts, which is utilised to a great extent for actuating a winding capstan, the turbine having been substituted for a reciprocating steam engine, the coal consumption of which was rather high. According to reports published by Mr. W. Morris, engineer-in-chief of the mine, no other means would have allowed as economical results to be obtained as have been secured by using a low-pressure turbine.

Figure 4 next represents a plant installed at the mines of Klein-Rosseln, Germany, comprising two generator sets which utilise the exhaust steam from two winding engines of a steam consumption of about 13,000 kilogrammes per hour. This accumulator is of the water-accumulator system. The generator set (constructed by Brown, Boveri & Co.) has an output of about 370 kilowatts, the speed of rotation being 3,000 revolutions. The consumption of the turbine is 17 kilogrammes per kilowatt-hour (that is 11.3 kilogrammes per horse-power-hour). The initial pressure is 1.3 kilogrammes per square

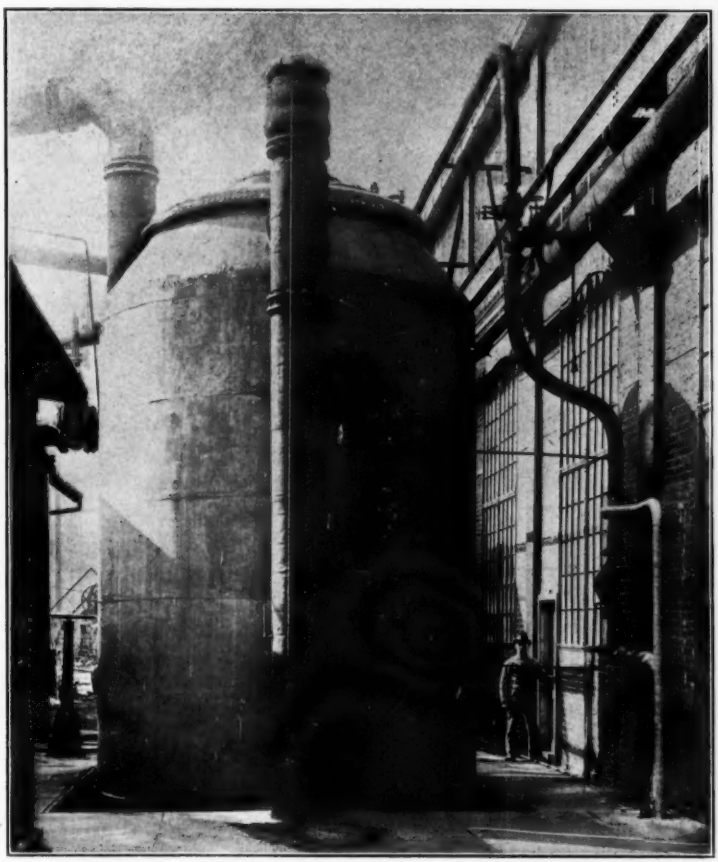


FIG. 7. ACCUMULATOR OF THE POENSGEN STEEL WORKS AT DÜSSELDORF.

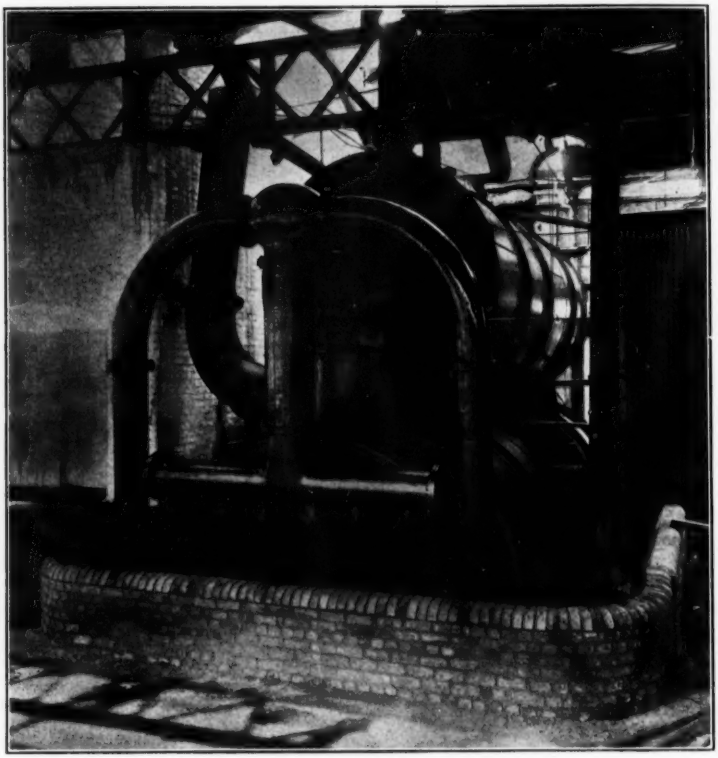


FIG. 8. ACCUMULATOR, STEEL COMPANY OF SCOTLAND.

centimetre and the final pressure .10 kilogramme per square centimetre, the latter being obtained by means of a Balcke condenser giving a vacuum of 90 per cent; the current produced is three-phase current.

Another application of the system has been made at the Zollverein Mines, Figure 5. This is the most extensive low-pressure turbine plant ever installed at a mine, comprising three primary engines, two winding engines of the double twin type, and a ventilating engine, the aggregate consumption being 16,000 kilogrammes of steam per hour. A steam accumulator of 50 tons weight in connection with a Balcke condenser was installed at this plant. The current-generator set of an output of 1,000 kilowatts consists of a low-pressure turbine and a 3-phase alternator constructed by Brown, Boveri & Co. This engine, with a vacuum of 92.32 per cent and a feeding pressure of

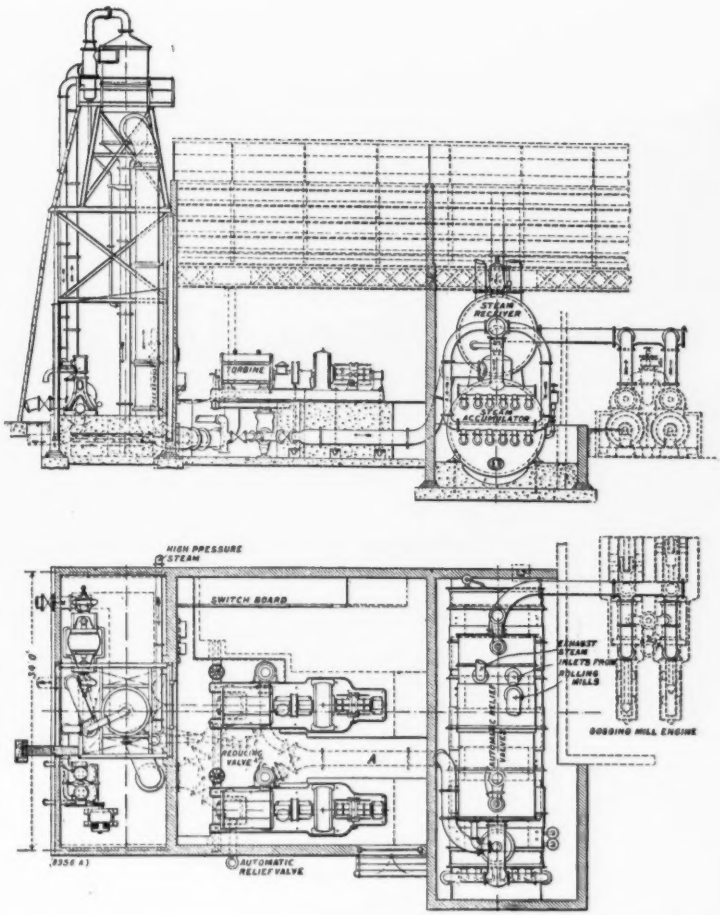


FIG. 8. PLAN AND LONGITUDINAL SECTION OF ACCUMULATOR AND EXHAUST-STEAM TURBINE INSTALLATION, STEEL COMPANY OF SCOTLAND.

1.094 kilogramme per square centimetre, shows a consumption of 14.77 kilogrammes per kilowatt hour when working at full load, which consumption is reduced to 14.34 kilogrammes per kilowatt-hour (or 9.6 kilogrammes per horse-power-hour) in the case of overloads of 70 per cent, the feeding pressure being 1.155 and the vacuum of the condenser 8.29 per cent.

After installing this plant, a live-steam engine of 600 kilowatts, which formerly ensured the electric service of the pit, could be shut down, while providing for the operation of an electric compressor of 400 kilowatts. In spite of this increase in energy, a saving of 10,000 kilogrammes of steam per hour could be ensured from boilers being shut down. In view of these excellent results, the managers of the mine have decided on installing an identical plant in another pit of the Gutehoffnungshütte concern.

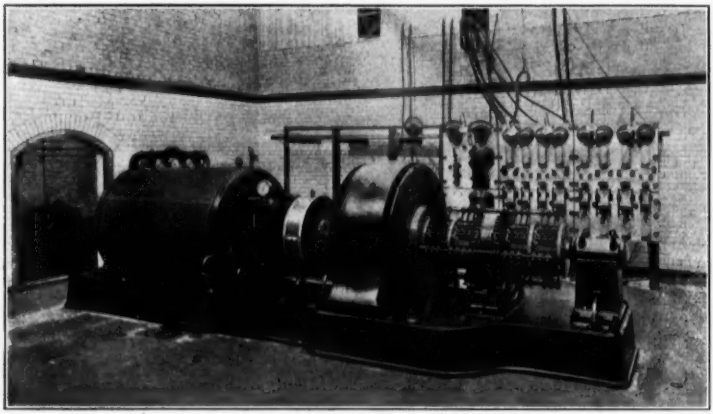


FIG. 9. TURBO-DYNAMO, THE STEEL COMPANY OF SCOTLAND.

Of other low-pressure turbine plants installed in German mines (the constructors being Messrs. Balcke & Co., the German representatives of Prof. Rateau) the plant recently inaugurated at the Alma pit of the Gelsenkirchen mines (Figure 6) should be mentioned. In this plant a number of tests have been made on a low-pressure turbine of an output of 400 kilogrammes, the results bearing out completely the previsions of the constructors. An efficiency of 66 per cent was recorded.

The plant installed at the Poensgen steel works of Düsseldorf (Figure 7) in connection with an existing central condensing plant comprises an accumulator of the cast-steel type which contains about 120 tons of cast steel; the several machines of this steel works of which the largest are a reversible mill and hammers, are arranged in connection with this accumulator, the aggregate amount of steam consumed being 11,500 kilogrammes per hour.

The current-generating set is a low-pressure turbine turning at a speed of 1,400 revolutions and driving two continuous-current dyna-

mos direct-coupled to the turbine. The vacuum of the condenser is about 66 centimetres mercury and the total amount of energy recovered by this set is 650 kilowatts. This energy is used for lighting purposes and for operating the roll trains and auxiliary machines.

The increase in the consumption of these machines, as compared with their working in connection with the central condensing plant has been found to be only 1,700 kilogrammes of steam per hour, and the saving ensured by condensing was 15 per cent; it now exceeds 40 per cent after the inauguration of the low-pressure turbines.

The Rateau system of low-pressure turbines worked by exhaust steam has further been applied at the Rombach steel works, which already comprised a powerful gas-engine central station, fed by blast-furnace gases. Still, the Rateau plant has been found so advantageous in operation, that after eight months' working the managers of the steel works decided on erecting another plant comprising a 550-kilowatt electricity-generating set.

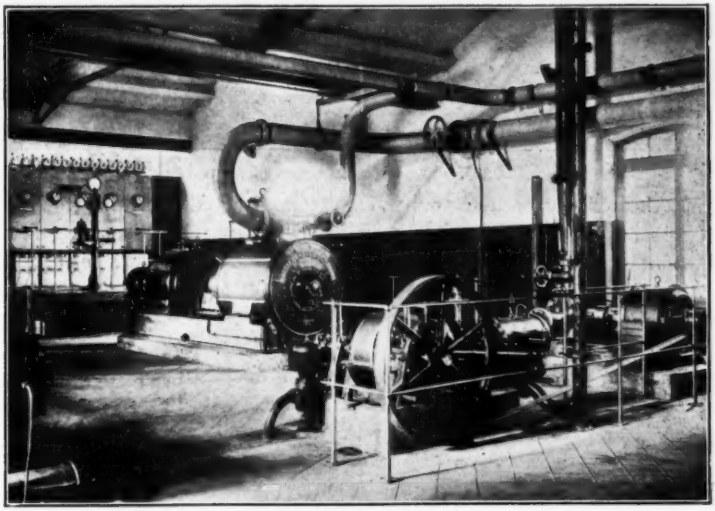


FIG. 10. TURBO-DYNAMO, MINES OF ROCHE-LA-MOLIERE, FIRMINY.

The first installation comprises four water accumulators of two stories each, each 2.6 metres in diameter and 7.5 metres in length, of a total capacity of 100 tons of water. These accumulators are fed by two three-cylinder reversible rolling-mill engines, which formerly worked on central condensing plants, with a total consumption of 25,000 kilogrammes per hour. As the primary engines are worked by

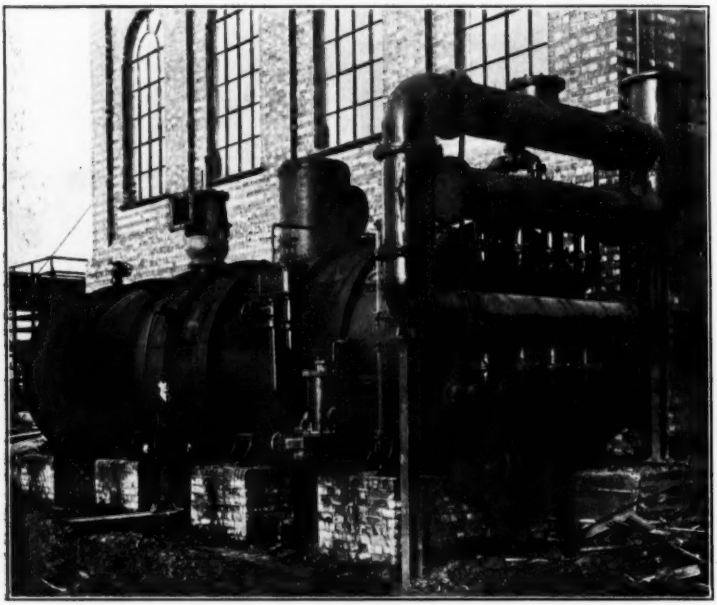


FIG. 11. ACCUMULATOR OF THE MINES AT DONCASTER.

superheated steam, the amount of water discharged from the accumulators is practically nil. Each of the two electricity-generating sets has an output of 550 kilowatts and supplies continuous current at 230 volts, which is utilised in the first place for operating the electric roll trains in conjunction with the energy generated at the gas-motor central power plant.

The first plant erected in an English steel works is that of the Steel Company of Scotland near Glasgow. In Figure 8 is shown the accumulator constructed by P. J. Mitchell, which comprises a double-story shell 3.5 metres in diameter and 10 metres in length, surmounted by a tank 2.75 metres in diameter and 8 metres in length. The six steam-feeding pipes are distinctly visible in the figure. This accumulator contains 55 tons of water and receives 20,000 kilogrammes of steam per hour, which is supplied by several primary engines, viz. a two-cylinder twin engine of 1.1 metre diameter and 1.35 metre stroke driving a reversible roughing-down roll train, a similar engine driving a finishing roll train, and four steam hammers. The generating set comprises two units of 450 kilowatts each, rotating at 1,500 revolutions and yielding continuous current at 230 volts.

This current is utilised for lighting purposes, as well as for operating several plants, of which the continuous roll trains are the most important and use the greatest amount of energy.

In order to give an idea of the results ensured with this low-pressure turbine plant, it may be said that all the steam engines of the steel works, apart from those driving the roughing-down roll trains and hammers could be shut down. Some very careful tests were made during the first six months of operation of the first 450-kilowatt unit, when an aggregate saving of 4 per cent on the whole of the coal consumption of the works was secured. The managers, by utilising this unit, further avoided the necessity of purchasing six boilers, while saving the payment of the stokers required to operate these. In view of the satisfactory results, the second unit was installed.

In the Schoeller & Co. steel works at Ternitz the exhaust steam from 14 hammers of 200 to 10,000 kilogrammes, of a pass, and two small feeding pumps of an aggregate consumption of 5,000 kilogrammes per hour, is utilised for the operation of low-pressure turbines. The accumulator is made up of a double-story shell of 2.75 metres diameter and 8.5 metres length, surmounted by a buffer tank 1.5 metres in diameter and 4 metres in length which contains 33 tons of water. The current-generator set of an output of 300 horse-power yields continuous current at 220 volts.

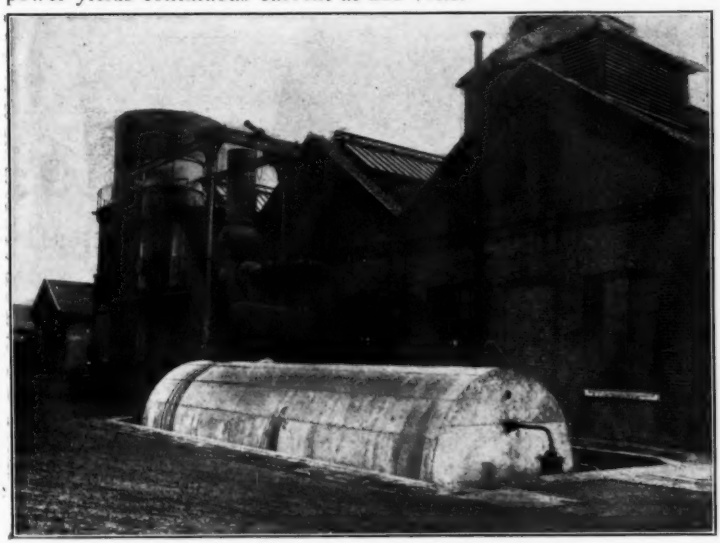


FIG. 12. ACCUMULATOR OF THE BÉTHUNE MINES.

The plant utilised at the Roche-la-Molière mines (Figure 10) is especially interesting in so far as a very interesting problem, viz. that of effecting the pumping of a pit with the steam from the hauling engine, that is to say without any expense as regards fuel, has been solved there under the most satisfactory conditions. This plant comprises a water accumulator of 25 tons consisting of an old boiler shell receiving the exhaust steam from a hauling engine and continually working auxiliary motors. The total amount of steam used up per hour by these various machines is about 4,500 kilogrammes, of which 3,500 as an average corresponds to the hauling engine. The current-generating set comprises a low-pressure turbine and a three-phase alternator of an output of 250 kilowatts at 1,800 revolutions. This

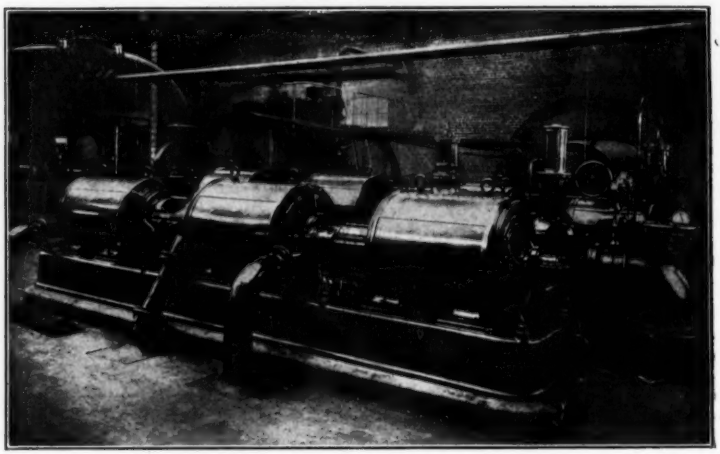


FIG. 13. TURBO-COMPRESSORS OF THE BÉTHUNE MINES.

set will yield 1 kilowatt with a consumption of steam of 13 kilogrammes per hour, the feeding pressure being 1 kilogramme in absolute value per square centimetre and the final pressure 0.1 kilogramme per square centimetre. The latter is obtained by means of a barometric condenser of the Balcke system which with refrigerated water gives a vacuum of 90 per cent. The energy produced by the turbine serves to actuate the condensing plant and two centrifugal mining pumps operated by electro-motors. These pumps, which are constructed on the Rateau system, will lift 100 cubic metres and 60 cubic metres per hour respectively, to 125 and 220 metres respectively.

After installing this plant it was found possible during the day

operation, while working the pumps and without any additional consumption of steam, to pump out the water from two pits, which operation had to be carried out formerly by hand, the resulting saving being 13,000 francs during 9 months. Several tests have shown that though the accumulator was not impervious to heat, the losses due to conduction and radiation did not exceed 2 per cent of the weight of the steam.

The plant installed at the Doncaster mines (Figure 11) is interesting in so far as the energy produced by the aid of exhaust steam there serves for actuating a set of centrifugal sinking pumps.

The instance of the Béthune mines (Figures 12, 13) derives additional interest from the fact that it affords the first examples of an installation of multicellular high-pressure turbo-compressors on the Rateau system. The accumulator contains 36 tons of water and is fed by an intermittently acting hauling engine and ventilating motor, and a continually working pump motor, the steam supplied by these three engines amounting to 6,000 kilogrammes per hour. The low-pressure turbines, as above mentioned, serve to operate a centrifugal turbo-compressor drawing in 60 cubic metres of air and compressing it to a final pressure of 7 kilogrammes in absolute value per square centimetre.

These centrifugal compressors are of quite recent invention and were discussed at the engineering conference of the Institution of Civil Engineers held on June 21. These pumps would seem to be destined to prove extremely useful, the more so as they are susceptible of considerable improvement, while preferable in many cases to the ordinary reciprocating or piston compressors. They are especially suitable in mining plants, in which compressed air must be used for operating the hauling engines, and where a direct coupling with the low-pressure turbine is quite easy.

The system of low-pressure turbines for utilising the exhaust steam in connection with a steam accumulator not only affords a means of considerably improving any existing plants, but of fitting up new plants on quite modern lines for maximum efficiencies. While a concentration of the different operations in a single electrically driven plant will be found suitable in many cases, the considerable drawbacks to such an arrangement cannot be left out of account. Any serious breakdown in the central station is, in fact, bound to result in a discontinuance of the whole service. It will therefore in many cases be found preferable, instead of electrifying a given plant, to improve its output by the installation of the system above outlined.

STEAM PRODUCTION FROM THE CHEAPER GRADES OF ANTHRACITE.

By William D. Ennis.

The first part of Mr. Ennis' discussion, published last month, dealt with the physical and chemical characteristics of the small sizes of anthracite and their commercial importance. This concluding section discusses the mechanical problems of air supply, grate and heating surfaces, stoking, draft, etc., which affect their economical use in the boiler furnace.—THE EDITORS.

LOW-GRADE coals offer relatively high mechanical resistance to the passage and diffusion of the air supplied. They naturally burn more slowly, and consequently, for the burning of a stated amount of such coal, either excessive draft or excessive area of grate may be required. As a rule, both are required. With soft coal, a rate of combustion of 30 pounds per square foot of grate per hour is not considered excessive; with a good quality of anthracite, 15 pounds to 18 pounds per square foot of grate per hour would be a corresponding figure. Fine sizes of anthracite would be limited to a rate of 6 to 10 pounds, unless the draft were greatly increased. By increasing the draft to 1 inch of water and upward, rates of combustion can also be increased, until in the locomotive, with draft intensities as high as 2, 3 and 4 inches, rates of combustion of 60, 80, and 100 pounds are reached. The locomotive boiler is, however, always worked several times beyond the rating which is customary for stationary boilers, viz., 3 to 4 pounds of water evaporated per square foot of heating surface per hour. At such a rate of evaporation, the stationary boiler, burning soft coal at a 30-pound rate of combustion, should have a heating surface equal to at least 65 times its grate surface. Burning ordinary anthracite at a rate of 20 pounds, the heating surface would be over 40 times the grate surface. Burning fine sizes at 15-pounds rate, with draft somewhat forced, the grate surface would be rather more than 1/40 the heating surface. As the quality of fuel is decreased, the relative amount of grate surface must always be increased. This leads to wide fireboxes on locomotives, and to narrower ratios of grate and heating surfaces in stationary practice; the reason being that decreased rates of combustion produce a decreased amount of heat to be taken up by the boiler heating surface. Whether it is desirable to reduce greatly the amount of heating surface is doubt-

ful. The tendency of business is always toward intensified operation, increased production. Year after year, we run our mills harder, load our engines more heavily, and demand higher rates of evaporation and combustion at the boilers. The average plant burns 50 per cent more coal per square foot of grate per hour than it did twenty years ago, and the demand is for still more. This demand is a corollary of industrial prosperity. As facilities for burning low-grade fuels improve, so that higher rates of combustion become common, the opportunity of saving in cost by skimping the boiler heating surface will look less tempting. At the moment, it would seem that a ratio of heating surface to grate surface of 40 to 1 was ample for any hard coal of grade below pea; ten, or even five, years hence, ratios of 50 to 1 or even 60 to 1 may prove to be the thing, and power plants unfortunately equipped on a 40 to 1 basis will be obliged to get along at relatively low rates of combustion, or to force their boilers beyond the economical obsorbing capacity of the heating surface. In other words, they will have to ride on the caboose while their competitors travel on the Limited, or else will be obliged to see their dollars pour out of the top of the chimney.

The following figures are given* as representing the draft desirable for the specified rates of combustion, per square foot of grate per hour, using No. 1 buckwheat coal:

Rate of Combustion.	Draft in Inches of Water.
10	0.30
15	0.45
20	0.70
25	1.00

With soft coal, at high rates of combustion, the usual difficulty is (1) an excess of air supply and (2) either an insufficient amount of heating surface or the short-circuiting of the heating surface by the hot gases, either of which conditions results in an unduly high temperature of flue gases. With low-grade hard coals, the flue-gas temperature is not so apt to be excessive; besides the loss due to excess of air, the principal source of waste is from incomplete combustion due to insufficient intensity of draft. The two conditions of insufficient draft intensity and surplus air supply are by no means incompatible.

Hard coals are generally hand-fired. The size of any particular grade is fairly uniform; there are no large lumps to break up; ordinary furnaces and grates are adapted to all but the finest sizes; there is no need of special devices for consuming the hydrocarbon, since the total volatile ranges under 7.7 per cent of the total combustible.

* The *Electrical World*, September, 1906, p. 633.

It requires a little more skill, with hard coal,* to fire so as to "keep up steam," but not so much skill to avoid wasteful and inefficient combustion, as in the case of soft coal. The fire must be kept level, well covered, free from air holes, and the whole surface in as nearly as possible the same condition as to stage of combustion. Cleaning and "poking up" should be as infrequent as possible, although large clinkers must not be allowed to stop the movement of air. The thickness of the fire and the amount of draft must be mutually regulated in accordance with each other so as to approach as closely as possible to the theoretically desirable amount of air supply. If the fire is too thick, the air supply will be deficient, combustion incomplete, and shooting blue flames will appear over the surface of the fuel. The furnace temperature will be low, and the whole furnace will have a "dead" look. If the fire is so thin or broken as to permit of an excessive supply of air, the low percentage of CO_2 in the flue gases is the best indication of the low efficiency.

The difficulty of keeping the fire free from clinker without almost incessant raking and poking has been the cause of the introduction of various shaking, dumping, and rocking grates, by means of which, without opening the fire doors, the bed of coal may be agitated and finely broken up, in sections, one section at a time being operated so as to avoid chilling the furnace. There is of course some cracking of the fire even with these grates, resulting in a large excess of air for a short time at least. The loss of fuel to the ash is somewhat increased, as a rule, over that experienced with careful hand firing, the increased loss seldom ranging below 2 or 3 per cent of the total heat in the fuel. This is a small matter as compared with the loss due to the interference, by clinkers, with the desirable amount of air supply, or even with the loss due to cleaning a non-clinkering coal through the fire door.

The necessary size of air space in the grate bars depends entirely upon the amount of tendency to clinker. It is usually considered that 30 to 50 per cent of air opening is desirable, and that the air spaces should never exceed ⅜ inch in width; but even this width has been found insufficient to avoid clogging by clinker, and Professor

* A coal is known as "hard," or anthracite, when the "fixed" or non-gaseous carbon is from 92.3 per cent upward of the total weight of combustible in the fuel. Thus, if coal on analysis shows 80 per cent fixed carbon, 5 per cent hydro-carbon, 7 per cent ash, 8 per cent moisture, then the combustible part of the coal is 85 per cent of the total, and the fixed carbon being $80 \div .85 = 94$ per cent of the combustible, the coal is anthracite. Coal in which the fixed carbon constitutes from 87.5 to 92.3 per cent of the total combustible is semi-anthracite. Semi-bituminous coal has a fixed-carbon ratio of from 75 to 87.5 per cent; true bituminous coals have a ratio below 75 per cent. It is worthy of note, therefore, that soft coal differs from hard in containing less fixed carbon, and more hydrocarbon or volatile matter. It is this relatively high percentage of volatile hydrocarbon that causes most of the difficulties in burning soft coal.

Kent reports one instance in which a 1/2-inch space clogged fast from fusing ash even with 1/2 inch of draft. On the other hand, tapering holes of 1/2-inch diameter in flat grates, giving only 25 per cent of air space, have been favorably reported, and in one case, with a non-clinkering coal, 1/8-inch air spaces aggregating 15 per cent of the total grate area gave ample air supply. The only general rule that can be laid down is that the air space should be made as narrow as is possible, consistent with the tendency to clinker of the coal that is to be used. The loss of coal to the ash pit will be always in simple proportion to the size of the air openings.

The usual liberal tables for chimney dimensions to suit given capacities of steam boilers are based on a fuel consumption of 5 pounds per horse power per hour. With anthracite coal, the usual allowance of 1/3 square foot of grate surface per horse power would permit of a rate of combustion of 15 pounds per square foot per hour. Ordinary chimneys permit of somewhat higher rates of combustion than this; but nevertheless there is no question but that under any reasonable limitations of chimney cost or height, the maximum possible rate of combustion is soon reached. Even with soft coal, it cannot greatly exceed 40 pounds of fuel per square foot of grate per hour, with chimneys as usually designed. If we take the normal consumption as 20 pounds, the maximum corresponds, therefore, to a 100 per cent overload. The chimney, therefore, besides being a remarkably inefficient machine, is remarkable also for its sharply limited overload capacity. The fan is more efficient, has a much wider overload capacity, and is absolutely independent of atmospheric conditions.

Why, then, should not the fan be applied universally where high draft intensities are required? Probably the principal, if not the only, reason is that the chimney has no parts to break down or wear out, while the fan has many such parts. Fan installations are therefore frequently made duplicate; and where not in duplicate, it is good practice to keep on hand a very large and complete assortment of spare parts. Any machine with moving parts must wear out and break down, eventually. Fans for draft, while cheaper, more efficient, and more controllable to conditions, involve almost a certainty of interruption to the operation of the plant, sometime. The fan, moreover, consumes some fuel and some labor is required to attend to it. The chimney *appears* to consume neither fuel nor labor; but the chimney will not burn fine sizes of coal at reasonable rates of combustion, and will not respond to heavy overload requirements. Each device—fan

and chimney—possesses merits and demerits which the other lacks. Why not, therefore, combine the two, obtaining the merits of both and eliminating the demerits of either? The chimney can be used for normal conditions, to ensure production and abolish operating expense; the fan can take care of overloads, variations in the weather and the fuel, and may assist the chimney in providing draft for cheaper fuels. The chimney, then, is the apparatus, and the fan becomes a refinement, or economizing device attached to it.

This combination of chimney and fan could be made by placing the fan between furnace and chimney, producing induced draft, and providing a by-pass so that the gases would not pass through the fan when the latter was not being used. For reasons which will be explained, there are advantages in using the fan as a *forced* blast fan rather than for induced draft, discharging from the fan into closed ash pits. By properly and mutually adjusting the speed of the fan and the position of the back damper, or in other words, by controlling the gas-outlet area in proportion to the amount of air supplied for combustion, *balanced draft* can be produced in the furnace—a condition in which, while the air is moving at its usual or any desired velocity through the fuel, and consequently burning it, the exit of the gases from the furnace is so retarded that within the latter there may exist a state of pressure—very slight, it is true, but still a pressure instead of a suction.

When the gases in the furnace of a steam boiler are under suction, they naturally follow the shortest possible course to the outlet, into the smoke breeching. The result is that many portions of the furnace and boiler heating surface are not impinged upon by these gases. The rapid, direct movement through the furnace "short circuits" some of the ends and corners. With "balanced draft," the gases are puffed back, filling every portion of furnace and setting, coming in contact with every square inch of the heating surface, and passing the heating surface at a relatively less velocity than when under suction. It has been known for some time that there were certain important economical advantages in "balanced draft," and various devices, said to be more or less crude, have been employed to effect it. It has been made the subject of commercial promotion within a comparatively short time. This feature of the system we shall not discuss, proposing rather to investigate the principles underlying "balanced draft" than the devices by which it is proposed to produce it.

There are many theories advanced to account for the increase in efficiency that is usually secured by the installation of balanced draft. Some of these have been disputed and cannot be said to be definitely

established. Others, which we will consider first, offer obvious reasons for the good results obtained.

1.—Avoidance of short circuiting. It is a well-known fact that good results always follow the application of any device which causes the gases to more fully and thoroughly impinge against the heating surface. Tubular boilers are more efficient than plain cylinder boilers; locomotive boilers are surprisingly efficient, when the enormous overloads are considered, largely because of the small tubes used. The application of retarders to the tubes of horizontal boilers frequently effects a large saving. In one series of tests conducted by me, the saving in fuel due to the installation of retarders was 9.6 per cent. (Trans. A. S. M. E., XXVIII, 4, 875.) All of these high efficiencies are due to the thorough impingement of the heated gas against the heating surface in all of its parts.

2.—A large amount of air is drawn through leaky fronts, doors, tops, and through cracked settings, under ordinary draft conditions. Besides this, the bricks composing the settings are themselves porous and permit air to pass through them. This can be remedied to some extent by painting the setting with paint made from specially "bodied" linseed oil, which provides an absolutely impervious skin, sometimes remaining intact even when the brickwork cracks underneath it. The infiltration of air due to these causes is serious; so serious, in fact, that in analyzing flue gases it is necessary to take the samples of gas as close to the furnace as possible, in order to avoid getting a highly diluted sample on account of air leakage through the setting. Under balanced draft, there can be no infiltration of air into the furnace, through cracks or interstices, the tendency being rather for leakage to be in the other direction. Further, there is no dash of cold air when the fire doors are open, the draft through the fire door being outward rather than inward. The entrance of cold air into the furnace, from any of these causes, always checks combustion and causes waste of heat. With balanced draft, this waste is avoided. Furthermore, influx of cold air against highly heated boiler surfaces results in rapid deterioration of the boiler. The high temperature due to good combustion is far less injurious than the irregular heat and frequent blasts of cold air on heated surfaces that are inseparable from natural draft.

3.—The factor of overwhelming importance in the economical operation of steam boilers is the regulation of air supply. With hand firing and hand control of damper, the position of the last ought, theoretically, to be changing constantly in accordance with the condition of the fire and the demand for air. In practice, under the best

operation, it is probably changed at the moment of firing and once more between intervals of firing. Under the usual mode of operation in the vast majority of plants, the damper is touched only when the steam goes "down" or the pop valves begin to sing. With damper regulators, control is automatic in accordance with the steam pressure, rather than in accordance with the requirements of the fire. With balanced draft and a stoker the speed of which is controlled by variations in the steam pressure, the condition of the fire, the pressure of steam, the position of the damper and the quantity of air supplied are all under simultaneous, concurrent control, resulting in a variation of air supply precisely in accordance with the variation in rate of combustion, without any annoying and wasteful modifications due to the infiltration of cold air through the boiler setting. Balanced draft automatically controls the air supply in accordance with the demands imposed by varying rates of combustion, in a manner superior to that practised by the best fireman and not to be at all compared with that practised by the average fireman. Even if natural draft could give equally efficient combustion, balanced draft more perfectly maintains the conditions of efficient combustion during variations in rate of combustion.

4.—Assuming these merits conceded, the principal claim made for balanced draft has now to be considered. This is, that with "balance" in the furnace, the quantity of air supplied, accidentally or otherwise, is less than with natural draft.

If this be true, certain advantages must follow:

a.—The percentage of CO_2 in the flue gases will be higher and the efficiency vastly increased, due to the reduction of excess air.

b.—The quantity of air being decreased, its velocity in passing through and out of the boiler setting will also be decreased, giving more time for the absorption of heat by the boiler and resulting consequently in more complete absorption, lower temperature of flue gases, and higher efficiency.

c.—The necessary intensity of draft for the mechanical texture and condition of the coal can be produced without reference to the actual quantity of air supplied, so that sufficient *force* of draft can be provided for burning cheap fuels without at the same time providing any increase in the *quantity* of air supplied.

These advantages are so important, that the question whether balanced draft decreases the quantity of air supply is worthy of serious

consideration. In the first place, under first-class operation, very fine regulation of air supply has been obtained with natural draft. Some tests quote results of flue-gas analysis showing CO_2 upward of 14 per cent, corresponding to an excess air of 30 per cent and a heat loss due to air of 13 per cent. Now the maximum possible percentage of CO_2, without any excess air whatever, is only 21 per cent, corresponding to a heat loss of about 10 per cent, or a 3 per-cent saving over the test quoted. It would be ridiculous to claim, therefore, that balanced draft could show any result greatly superior to those of such tests. It is not to be doubted that with natural draft, equally good results, or results nearly equally good, may be obtained under proper auspices. The question before us, however, is whether under ordinary operating conditions, balanced draft is more likely to produce results more nearly correct.

In order to produce a definite intensity of draft, there must be a definite velocity of air through the fuel. With any kind of draft this velocity is produced by a difference in pressure in the ash pit and furnace. With forced draft, chimney draft, induced draft, or balanced draft, the (positive) pressure in the furnace must be less than that in the ash pit, in order that air may flow from the latter to the former through the fuel. For the same fuel, the same difference of pressure must be maintained, whatever system of draft is used. Further, the egress of the hot gases from the furnace depends upon a fixed difference in pressure in the furnace and at the outlet of the smokestack; and this difference is also fixed without regard to the system of draft employed. In any of the systems, therefore, there is a definite resistance to the passage of air through the fire, and another definite resistance to the passage of the gases out of the furnace. The sum of these resistances must be overcome by the total draft. The relation of these various pressures to the external pressure of the atmosphere is of no consequence, but only the mutual relations of the pressures themselves. It is difficult to see, therefore, how the percentage of excess air is necessarily diminished by the use of balanced draft, although in practice we know that it almost invariably *is* diminished.

The point of maximum efficiency in a steam-boiler furnace is reached when all the carbon in the coal is burned to CO_2, resulting in a gas which contains, by volume, about 21 per cent of CO_2, no excess air being present. In practice, there is always some excess air, and the percentage of CO_2 is always less than 21; even under the very best conditions about 30 per cent of air in excess of requirements is

present. This excess is necessary and is always found, because of the imperfect mixing of the fuel and air in the furnace. With balanced draft, all the conditions are present for perfect mixing; sustained high temperature, slow movement, thorough diffusion, and that suffusion which results from the condition of pressure in the furnace and leads to rapid and intimate mingling of the molecules. From the superiority of mixing alone, balanced draft results in better combustion, as evidenced by high CO_2, and *permits* of cutting down the amount of air supplied *because* that air is entirely mingled with the gas from the fuel and not subjected to such stratification as prevents the mingling. Decreased air supply, with balanced draft, is due not to the relations of pressure and suction in ashpit and furnace, but to the fact that the condition of pressure in the furnace results in complete mixture of air and gas. The result is the same; the amount of air supplied may be decreased, without risking the formation of CO and the savings claimed to follow decreased air supply must be conceded to be theoretically as well as practically demonstrable.

Evolution is on the side of balanced draft. With intensified industrial activity we are continually forced to meet heavier overloads and more severe service conditions. We may add new boilers to our plants, or burn a better grade of fuel; but the existing chimney sharply limits the extent of progress. Let the time-honored chimney be "boosted" by the more modern fan, the two forming a tandem team, and we have vastly augmented the capacity of our entire plant at the lowest possible cost. We can burn cheaper coal and can make more steam. The combination of a fan with an existing chimney costs far less than a complete installation for either chimney, forced, or induced draft. Of course, men can and should fire more skilfully; air supply can be controlled by damper regulation; cheaper coal can be burned by other devices; high CO_2 and economical combustion can be obtained in other ways; but in no other way so surely, so quickly, so easily, and so cheaply. The plant that just manages to get along with run-of-mine coal and natural draft can easily use the 30 per-cent cheaper rice or barley coals with greater efficiency. The fine-sized coals are cheaper per B. T. U. to begin with, but cannot be burned with chimney draft. Help out the chimney with the fan, and not only the benefit of the cheap fuel, but also the benefit of more efficient combustion, is readily obtainable. With New York prices as they are at the present day, no power producer with a reasonably good load factor can afford to burn other fuel than the finer sizes of buckwheat coal, for steam generation.

A NEW MINERAL INDUSTRY—THE MANUFACTURE OF RADIUM.

By Jacques Boyer.

THE manufactory lately installed at Nogent-sur-Marne by M. Armet de Lisle bears but little resemblance to ordinary establishments; whole carloads of divers minerals are there treated for an ultimate product consisting of a few minute particles of radium salts. The photographs presented herewith show these modern alchemists at their tasks, upon which they labor as hard as their predecessors of the Middle Ages. Is not pure radium bromide, for instance, a new and most remarkable philosopher's stone, seeing that a single kilogramme of this precious substance would be worth 400,000,000 francs at the present time?

It is well-known that, as a matter of fact, radium has not yet been isolated in a metallic state, but exists only in the form of salts (chlorides, bromides or sulphates) possessed of a greater or less degree of activity, secured by stopping the operations of manufacture at certain determined points. The radio-active salts may be obtained throughout a scale of activity adjusted to the object for which they are desired. Thus, after the series of manipulations known under the name of the "gross treatments" the activity (taking uranium as unity) reaches 50 to 60; the first fractionings beyond this raise it to 1,000 and the final ones carry it to 2,000,000.

At the Nogent works the following minerals are treated:

Pitchblende (oxide of uranium associated with a large number of foreign substances) which is found principally at Joachimsthal and at Przibram in Bohemia, at Rezbanya in Hungary, in parts of Sweden, Canada, and in Colorado.

Autunite (a double phosphate of uranium and calcium) and pyromorphite (phosphate of lead) from the environs of Autun in France.

Chalcolite (double phosphate of uranium and copper) from Bohemia.

Carnotite (vanadate of uranium) from Portugal and Utah.

Thorianite (oxide of uranium and thorium) of which deposits exist in Ceylon.

Residues from the preparation of uranium, like those of Joachimsthal in which M. and Mme. Curie made the first discovery of radium.

On their arrival at the works all these minerals (except the pitchblende residues, which have already been pulverized for their preceding chemical treatment) are subjected to grinding. For this, the first of the mechanical operations, a variety of machinery is used—among other apparatus a jaw-crusher, a ball-mill and a stamp-mill. Following this, the manipulations differ for each mineral and a very complicated series of processes is to be met in their methodical progress through the works; for the Nogent establishment extracts all the radio-active substances (radium, polonium, actinium, uranium, thorium) which are found in the minerals it treats. Nor are the by-products neglected. The brief description following outlines the method employed in the case of pitchblende, or rather the pitchblende residues from which uranium has been removed. The "gross treatment" is carried on in wooden vats and in steel vats with agitators. One ton of residues requires five tons of chemicals and fifty tons of wash-water. The scheme of the consecutive reactions is as follows:

The residues from the uranium minerals contain sulphates of almost all the metals, and as the sulphate of radium is the least soluble of all, this property is used for its separation, through the medium of a progressive series of washings and of attacks, sometimes with acids, sometimes with alkaline solutions, and sometimes with water. These manipulations carry away each time the more soluble metals. The sulphate of radium always remains at the bottom of the tank and is recovered at the end of the series of manipulations which are thus conducted:

1.—The residues are mixed with concentrated hydrochloric acid, by which the larger part of the sulphates is dissolved. The solution is decanted and the solid residuum, which is then washed with water, retains the radium.

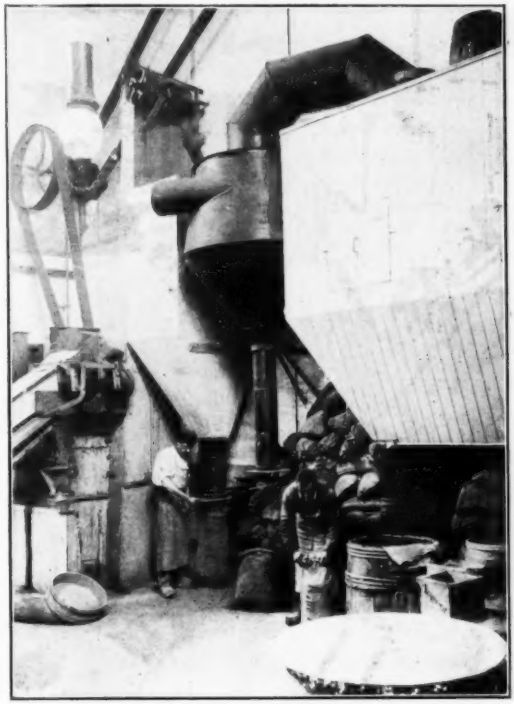
2.—To this deposit carrying the radium is added a boiling concentrated solution of carbonate of soda in order to transform into carbonates any remaining sulphates which resisted the preceding attack. Workmen stir the mixture with great wooden paddles and finally decant it and wash the residuum with large quantities of water.

3.—The residuum is treated with dilute hydrochloric acid. The solution now carries the radium. It is filtered and precipitated with sulphuric acid and thus is obtained crude sulphate of barium, radium-bearing and exhibiting an activity varying from 30 to 60. From 8 to 15 kilogrammes of these sulphates are recovered for each ton of original residues treated.

4.—To purify these crude sulphates (in which are found small quantities of lime, lead, iron, and actinium) they are boiled with a concentrated solution of carbonate of soda.

5.—The radium-bearing carbonate of barium treated with hydrochloric acid, furnishes radium-bearing chloride of barium.

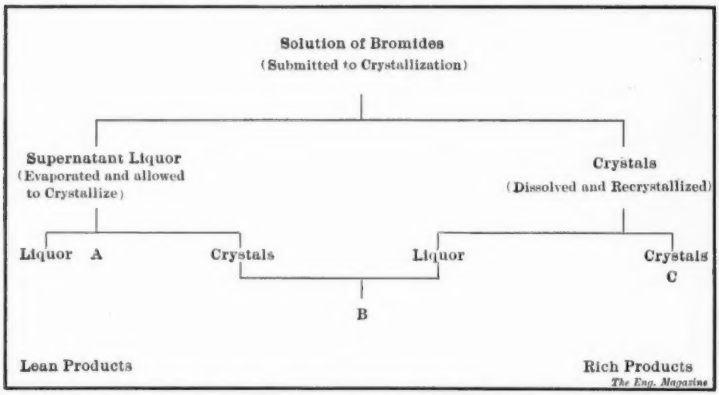
6.—After washing out, this radium-bearing chloride of barium is precipitated by carbonate of soda and the carbonate of barium thus obtained is transformed into bromide by hydrobromic acid. This impure bromide of radium, showing an activity of 50 to 60, is obtained in the proportion of one to two kilogrammes for each ton of uranium-mineral residues treated. The whole course of these delicate operations requires about two months and a half.



GRINDING RADIUM-BEARING MINERALS AT NOGENT-SUR-MARNE.

Next in order come the fractionings, which have for their purpose the preparation of radium-bearing bromides of barium of constantly increasing richness in radium. To secure this, the mixture of bromides is submitted to a series of crystallizations, first from pure water, afterwards from water to which hydrobromic acid has been added. Advantage is thus taken of the difference in solubility between the two bromides, the radium salt being less soluble than the barium. The mixed bromides are therefore dissolved in hot distilled water, and the solution is then brought to the saturation point at boiling temperature. It is then allowed to crystallize by cooling in a capsule, at

the bottom of which the fine crystals are collected and ultimately are separated from the supernatant liquid by decantation. These crystals exhibit an activity five times as great as that of the bromide in solution. By repetition of similar operations, both upon the liquor and the separated crystals, products extremely rich in radium are at last secured. The following diagram shows schematically the progress and relation of the successive manipulations:



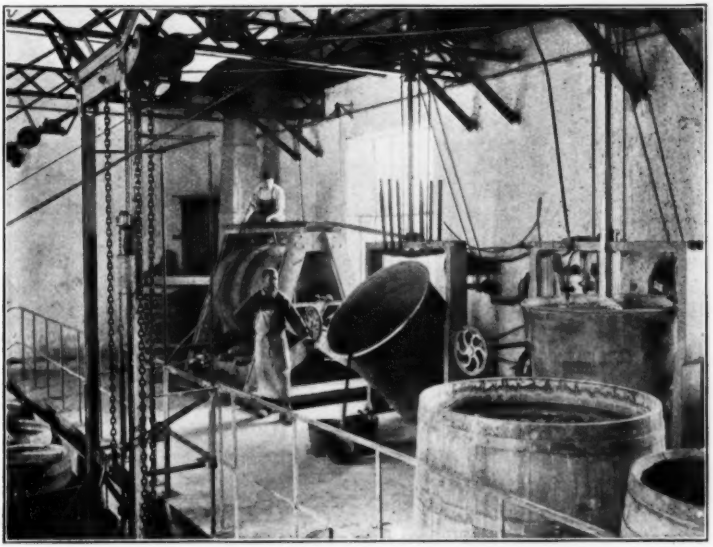
SCHEME OF FRACTIONAL CRYSTALLIZATIONS FOR CONCENTRATION AND PURIFICATION OF RADIUM SALTS.

We have thus to consider four products:

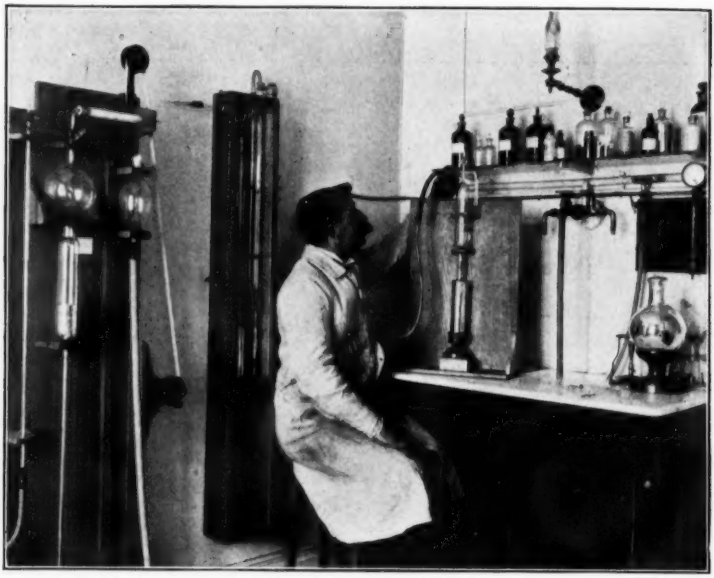
(1) A liquor, A, and (2) crystals, B, derived from the supernatant liquor of the first crystallization, and (3) a liquor, B, and (4) crystals, C, obtained by recrystallization from this first-obtained series of crystals themselves. These last crystals (which we might designate as the "C" series) are naturally the most active. The products obtained from the supernatant liquor of this process of crystallization are possessed of an activity about equal to that of the crystals of what we might call the "B" series obtained from the liquor of the first crystallization. These two lots are therefore combined. Each grade of the radio-active crystals is then submitted anew to a similar treatment, and the fractioning is carried as far as desired by like methods. However, when the "tailings" become too lean, and no longer show anything but an insignificant degree of activity, they are thrown away. And, on the other hand, the concentrates, very rich in radium, are set aside as finished.

The first set of fractionings constitute the last series of manipulations which reach the scale of industrial operations, and proportionately as the process advances the volume of material operated upon

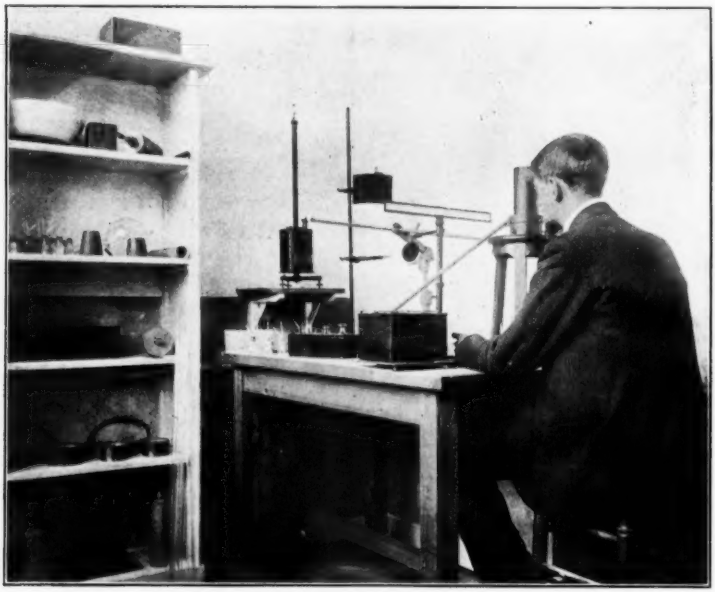
IN THE FRACTIONING LABORATORY.



VATS AND TIPPING KETTLES FOR THE PRELIMINARY TREATMENT.



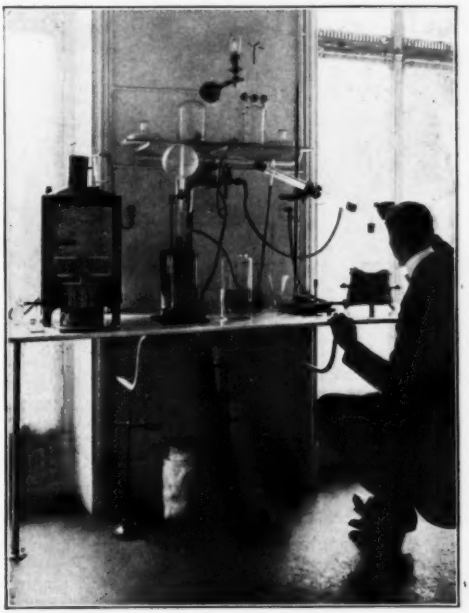
CONDENSING THE RADIUM EMANATION ON VARIOUS SUBSTANCES BY MEANS OF LIQUID AIR.



LABORATORY FOR THE MEASUREMENT OF RADIO-ACTIVITY.

decreases; so much so that by the time we reach a scale of activity 1,000 times that of uranium, each ton of residue originally treated is represented by only 30 grammes of bromide of radium. The operations are then transferred to the laboratory and treatment by the same general scheme is continued until after a large number of fractionings, which involve serious technical difficulties, a final product is secured consisting of one or two milligrammes of radium bromide of an activity 2,000,000 times that of metallic uranium.

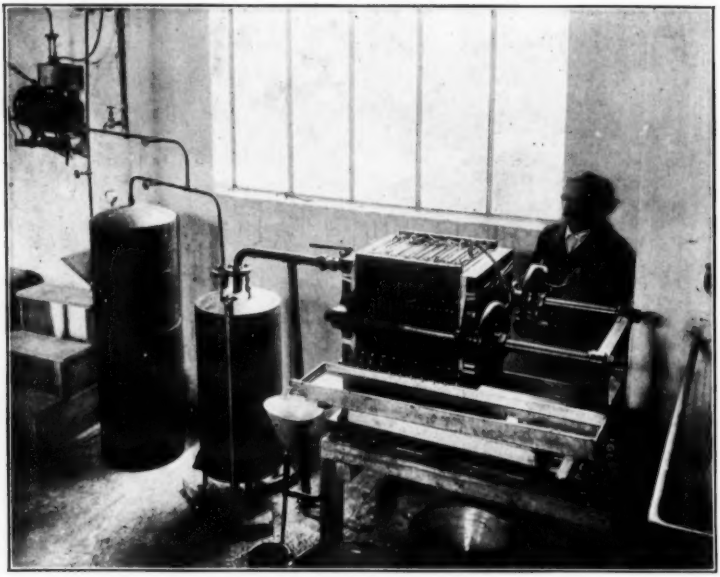
Beyond this, the laboratories of the Nogent works are occupied with the analysis of minerals, of the various products of manufacture, and of the residues. Microscopic examinations are also conducted, and, as some of the photographs show, accurate measurements are made of the radio-activity and the emanations of the products; sundry subjects also are radio-energized.



EXAMINATION OF MINERAL WATERS FOR RADIO-ACTIVE PROPERTIES.

In order to determine precisely the radio-activity of solid substances (radio-active minerals or salts of radium of varying concentration, etc.) use is made of the process indicated by P. Curie, which requires as essentials three pieces of apparatus—a plate condenser, a piezo-electric quartz sphere and an electrometer.

The lower plate of the condenser is raised to a high potential by means of a small accumulator battery, and the upper plate is connected with the electrometer and the quartz. Normally, as is known, no current passes between the two plates of the condenser, but in the neighborhood of a radium salt the air separating the two becomes a good conductor and allows the electricity to flow. Advantage is taken



FILTER PRESS FOR URANIUM SALTS.

of this current to deflect the needle of the electrometer, and this deflection is counterbalanced by an equal and contrary current obtained from the piezo-electric quartz. This compensating current, directly measurable, furnishes the measure of the radio-activity of the substance under examination, the instrument having first been standardized on a salt of known activity.

If it is required to determine the radio-active properties of a mineral water (an operation frequently demanded since it has been shown that many springs employed medicinally exhibit radio-activity) a considerable quantity of the water is boiled, and the gas thus obtained (after drying by the ordinary chemical methods) is introduced into a closed condenser which is then substituted for the plate condenser.

Finally, in these same works various substances are radio-energized, particularly medicines in which this treatment seems to excite curative properties. In this procedure the material to be treated is placed in a bulb and with the aid of a partial vacuum the emanation disengaged from a solution of bromide of radium is condensed upon it. This having been done the bulb is plunged into liquid air and sealed with a lamp flame when by electroscope tests it appears that the condensation is complete. Substances thus endowed with radio-activity retain the property for a long time.

PUBLIC LIGHTING SERVICE, CORPORATE AND MUNICIPAL.

A STUDY OF THE COST OF ELECTRIC STATIONS

By Judson H. Boughton.

Mr. Boughton's article is of special value because of the practical answers it gives to questions concerning the cost and the working of small and medium plants. These are just the installations for which it is often impossible to make an exhaustive expert study of conditions and design, such as would be undertaken by a great central station, and for which indeed preliminary figures may have to be made without the employment of a specialist. There is no attempt here to make "every man his own electrical engineer." No work of any importance should be entered upon without competent professional advice and supervision. But the clear presentation of average figures, compiled from a large number of plants working under a great variety of conditions, will suffice in many cases to give an approximate idea of the outlay and the returns to be expected, and will serve perhaps to indicate many promising opportunities for new undertakings. And in view of the persistence of the agitation for municipal ownership, the comments upon privately and municipally operated lighting stations, presented at the end of the article, may be studied with profit.—THE EDITORS.

THE design, construction and operation of electric-lighting plants to serve efficiently American cities of from 10,000 to 200,000 inhabitants, presents a diversity of problems with the widely differing local conditions encountered. There is, however, a set of general requirements and facilities for meeting them, including the generation from steam power, using coal as the fuel, of current to supply from 50 to 2,000 lamps, which is represented by the great majority of installations in this service. The experience gained from these plants is of much value, and deductions made from their performance are very generally applicable to the design and operation problems of the majority of plants of this class.

Although perhaps not of greatest importance, the question of plant location is the one which logically invites first attention, after the exact station capacity and distribution requirements and the fuel-transportation facilities offered have been investigated. Other things being equal, the site which will permit of the most economical distribution of current over the entire area to be served should be selected, but often this location is not accessible to railroads or docks, and if it be selected the coal-hauling account may become a much larger item than the transmission losses throughout the entire system. This is quite as true in small installations as in larger plants. Acces-

sibility to fuel supply should, then, be the first consideration in the average case, and following this, efficient transmission, with due reference to probable future expansion of lines and service. The ideal is realized when the aggregate of the interest on the site investment, the fuel-haulage account, and the transmission losses, is minimum.

Of buildings, it may be said that they are never too large and seldom too well built, although there are of course plants in which all elements of the ultimate objective—commercial efficiency—are disregarded by the designers. Substantial foundations should be built not only for each piece of machinery, but for the building, although the latter is to be regarded as a cover and not as a support for the former. Fire-proof construction has been found to be cheaper than insurance protection, which even though commanding high rates never fully covers the real loss sustained. Natural light is very desirable, as is good ventilation, and in modern construction windows are cheaper than walls. The general lay-out of the building should of course be such as to provide for the economical handling of fuel and ashes, and for the distribution of steam and transmission of power with least possible loss. Provision for expansion, and for handling and duplication of apparatus, should not be overlooked.

The machinery of the lighting plant may be considered in three distinct groups; the boilers and accessories, the engines, steam pipes and condensers, and the dynamos and switchboard. Concerning boilers for this service, it may be said that no one type is better than every other type for every set of conditions. High efficiency in the production of steam can be obtained only by the careful selection, setting, and firing of boilers which are adapted to the fuel available and to the other local conditions of service.

For smaller plants any well designed and constructed and properly set horizontal tubular boiler should give satisfactory results. In larger plants the water-tubular type is generally preferred on account of its greater steaming capacity, decreased floor space, and somewhat greater efficiency. In the economical operation of any type of boiler the fireman is the most important factor, and the exercise of training and intelligence in firing will save many times the amount of apparently high wages. A defective setting may likewise dissipate a considerable amount of heat which should be utilized.

By way of performance-comparison of the two general types of boilers, Isherwood submits the following figures, which are here reduced to a horse-power basis:

TABLE A. AVERAGE COSTS HORIZONTAL TUBULAR BOILERS, ACCESSORIES, CONNECTIONS AND SETTING.

Tubular Boilers, H. P.	30	50	60	70	80	90	100	125	150
Aver. Size of Boiler	44"x12'	54"x14'	54"x16'	60"x14'	60"x16'	60"x15'	66"x16'	72"x16'	78"x18'
Aver. Cost, Boiler and Fixtures, Full Front	$405	$595	$670	$725	$810	$940	$975	$1,010	$1,370
Aver. Iron Stack and Raising	60	95	98	110	120	125	130	150	240
Aver. Boiler Setting, Masonry	185	240	260	297	300	305	310	385	450
Aver. Hauling	15	15	15	20	30	30	30	30	40
Aver. Cost of Boiler Set	$665	$945	$1,043	$1,162	$1,270	$1,400	$1,440	$1,575	$1,970
Aver. Feed-Water Heater	55	90	90	105	120	140	140	220	220
Aver. Boiler-Feed Pump	55	70	70	70	90	110	110	125	145
Aver. Injector	14	14	14	18	18	20	20	24	28
Aver. Piping, including Engine Connections	75	105	115	130	140	185	195	245	310
Aver. Pump and Heater Foundations	14	18	18	18	21	21	21	21	28
Aver. Total Cost, Boiler, Stack, Heater, Pump, Set and Connected	$878	$1,242	$1,350	$1,503	$1,659	$1,876	$1,926	$2,210	$2,701

Water-tube—11 square feet heating surface, 3.3 pounds of coal; relative economy 100, relative rate of steaming 100.

Horizontal Tubular—16 square feet of heating surface, 4.0 pounds of coal; relative economy 91, relative rate of steaming 50.

The average cost of different sizes of boilers of the horizontal tubular type (which type has been more generally used), especially in smaller plants, is shown in Table A, which includes also data representing the cost of accessories and connections, and of setting. Five to seven per cent is a fair reduction to make from these figures for each boiler set in battery. Although always greater, the cost of the different types and makes of water-tubular boilers varies so much that a similar tabulation is of little value.

A supply of pure feed water, holding no lime or other matter in suspension or solution, and proper draft, are elements of importance in efficient boiler operation which must be provided for in the location and construction of the plant. Table B shows the sizes of stacks in varying heights which are usually built for various boiler capacities, and C and D represent the general dimensions and average costs of brick chimneys and iron stacks respectively Some progress has been made in the adaptation of automatic stokers and forced draft to lighting-plant service, but the greatest success has been met in installations of larger capacity than those here considered.

TABLE B. SIZES OF CHIMNEYS FOR STEAM BOILERS.

Square Chimney, Sides of Square.	Round Chimney, Diameter in Inches.	Area, Square Feet.	Effective Area, Square Feet.	Height of Chimney. 50 ft	60 ft.	70 ft.	80 ft.	100 ft.	110 ft.	125 ft.	150 ft.	175 ft.	200 ft.
				Commercial Horse-Power of Boilers.									
16x16.....	18	1.77	.97	20	25	30	....	....	....	....	....	....	....
19x19.....	21	2.41	1.47	35	40	40	....	....	....	....	....	....	....
22x22.....	24	3.14	2.08	50	55	60	60	....	....	....	....	....	....
24x24.....	27	3.98	2.78	65	70	80	85	....	....	....	....	....	....
27x27.....	30	4.91	3.58	85	90	100	110	....	....	....	....	....	....
30x30.....	33	5.94	4.48	....	115	125	135	....	....	....	....	....	....
32x32.....	36	7.07	5.47	....	140	150	165	180	....	....	....	....	....
35x35.....	39	8.30	6.57	....	....	180	200	220	....	....	....	....	....
38x38.....	42	9.62	7.76	....	....	220	230	260	270	....	....	....	....
43x43.....	48	12.57	10.44	....	....	....	310	350	365	390	....	....	....
48x48.....	54	15.90	13.51	....	....	....	....	450	470	500	550	....	....
54x54.....	60	19.64	16.98	....	....	....	....	565	590	630	690	750	....
59x59.....	66	23.76	20.83	....	....	....	....	700	730	780	850	920	980
64x64.....	72	28.27	25.08	....	....	....	....	835	875	935	1,020	1,100	1,180
70x70.....	78	33.18	29.73	....	....	....	....	....	1,035	1,100	1,215	1,300	1,400
75x75.....	84	38.48	34.76	....	....	....	....	....	1,200	1,300	1,420	1,530	1,630
80x80.....	90	44.18	40.19	....	....	....	....	....	....	1,500	1,640	1,770	1,900
86x86.....	96	50.27	46.01	....	....	....	....	....	....	....	1,880	2,000	2,200

TABLE C. BRICK CHIMNEYS.

Approx. Horse-Power.	Height, Feet.	Diameter Flue, Inside.	Outside Dimensions, Base Square.	Outside Wall. No. Brick.	Outside Wall. Cost @ $14 per M.	Cost, Fire Brick Lining, ½ Height.	Cost, Concrete Foundation.	Total Cost Chimney.
85	80	25 in.	7 ft. 5 in.	32,000	$448	$60	$90	$598
135	90	30 "	8 " 3 "	40,000	560	82	144	786
200	100	35 "	9 " 10 "	65,000	910	118	198	1,226
300	110	43 "	10 " 2 "	75,000	1,050	190	252	1,492
450	120	51 "	11 " 2 "	87,000	1,218	261	306	1,785
750	130	61 "	12 " 6 "	131,000	1,834	334	360	2,528
1,000	140	74 "	13 " 11 "	151,000	2,114	432	414	3,060
1,650	150	88 "	15 " 1 "	200,000	2,800	482	468	3,750
2,500	160	110 "	17 " 10 "	275,000	3,850	720	525	5,095

The cost of labor and fuel, the two principal items of expense in boiler operation, are indicated by tables E, F, and G, which represent an average of the conditions found in the United States. Table E shows the cost of coal per hour to generate 100 horse power of steam under ordinary conditions, with coal varying in price from $0.75 to $4.00 per ton, and with an evaporation of from 5 to 11 pounds of water per pound of coal. Thirty-five pounds of water at 212 degrees are treated as one boiler horse power, allowance being made for loss in delivering steam to the engine. The average evaporation is between 7 and 8 pounds of water per pound of coal. The corresponding

TABLE D. IRON STACKS.

Horse-Power.	Height, Feet.	Diameter, Inches.	No. of Iron.	Price, Stack Complete.
25	40	16	12 and 14	$60
...	40	18	12 " 14	70
...	50	18	12 " 14	85
75	50	20	12 " 14	90
...	50	26	12 " 14	105
...	60	22	12 " 14	110
100	60	24	12 " 14	125
...	60	26	12 " 14	135
...	60	28	12 " 14	150
125	60	28	10 " 12	190
...	60	32	10 " 12	205
150	60	34	12 " 14	165
200	60	36	10 " 12	215
225	60	38	10 " 12	230
250	60	42	10 " 12	260
300	60	46	10 " 12	290
400	60	52	10 " 12	340

cost of labor per hour to generate 100 horse power of steam is shown in Table F, figures representing the operation of from one to five boilers being given. It will be observed that the maximum capacity of one fireman is reached in a three-boiler battery, both in the eight-

hour and twelve-hour runs. The cost of labor per day to fire from one to five boilers of from 75 to 300 horse power is shown for both single and double shifts in Table G, from which the most efficient arrangement, from the standpoint of labor alone, will be apparent.

TABLE E. COST OF COAL PER HOUR TO GENERATE 100 HORSE-POWER OF STEAM UNDER ORDINARY CONDITIONS.

Cost per ton		$0.75	$1.00	$1.25	$1.50	$1.75	$2.00	$2.50	$3.00	$3.50	$4.00
Pounds of Water Evaporated per Pound of Coal.	5	.26	.35	.44	.53	.61	.70	.88	1.05	1.23	1.40
	6	.22	.29	.36	.44	.51	.58	.73	.87	1.02	1.16
	7	.19	.25	.31	.36	.44	.50	.63	.75	.88	1.00
	8	.17	.22	.28	.33	.39	.44	.55	.66	.77	.88
	9	.15	.20	.25	.30	.35	.40	.50	.60	.70	.80
	10	.13	.18	.23	.27	.32	.36	.45	.54	.63	.72
	11	.12	.16	.20	.24	.28	.32	.40	.48	.56	.64

TABLE F. COST OF LABOR PER HOUR TO GENERATE 100 HORSE-POWER OF STEAM UNDER ORDINARY CONDITIONS.

	Eight-Hour Run.				Twelve-Hour Run.			
Size of Boiler, Horse-Power	75	100	200	300	75	100	200	300
No. of Boilers, 1.....	$0.28	$0.21	$0.11	$0.08	$0.19	$0.14	$0.07	$0.05
No. of Boilers, 2.....	0.15	0.11	0.06	0.07	0.10	0.07	0.04	0.05
No. of Boilers, 3.....	0.09	0.14	0.07	0.06	0.06	0.09	0.05	0.04
No. of Boilers, 4.....	0.15	0.11	0.09	0.07	0.10	0.07	0.06	0.05
No. of Boilers, 5.....	0.16	0.12	0.07	0.09	0.11	0.08	0.05	0.06

TABLE G. COST OF LABOR PER DAY TO GENERATE STEAM UNDER ORDINARY CONDITIONS, USING COAL.

	Single Shift.				Double Shift.			
Size of Boiler, H.P. .	75	100 to 150	200 to 250	300	75	100 to 150	200 to 250	300
No. of Boilers, 1	$1.67	$1.67	$1.67	$1.67	$3.34	$3.34	$3.34	$3.34
No. of Boilers, 2	$1.67	$1.67	$3.34	$3.34	$3.34	$3.34	$5.00	$5.00
No. of Boilers, 3	$1.67	$3.34	$3.34	$3.34	$3.34	$5.00	$5.00	$5.00
No. of Boilers, 4	$3.34	$3.34	$3.34	$5.00	$5.00	$5.00	$6.68	$6.68
No. of Boilers, 5	$3.34	$3.34	$3.34	$5.00	$5.00	$5.00	$6.68	$8.34

More of a problem is presented in the selection of an engine properly adapted to local conditions than in the choice of the boiler, or in fact, of any other piece of station machinery. Questions of first and of maintenance cost and of operating efficiency are encountered, and with the many types and makes of engines on the market, the solutions offered often seem perplexingly diverse. The tendency is toward the use of direct-connected apparatus, which as now designed is regarded as standard. This arrangement, however, means in small units somewhat higher first cost, higher maintenance, and lower operating efficiency; in large units where operating economy demands the use of Corliss valve gears, and consequent low speed, the first

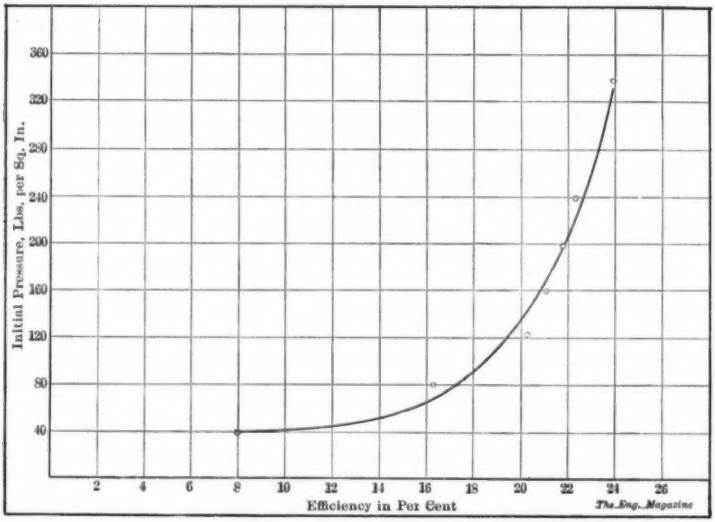
cost of both engine and dynamo is considerably greater. In any case the choice is to be made with proper consideration for first and maintenance cost and operating efficiency of engine and dynamo together, if the most satisfactory results are to be obtained.

In general it may be said that the best engine of any type is not too good. Although the design and proportions of each type have become standardized, it does not follow that the machine in question has been properly built and that the various parts fit and are in alignment. Engines which will operate efficiently and satisfactorily for continued periods can not be produced without adequate shop facilities. Ordinarily, the investment represented by the Corliss engine with the necessary shafting, pulleys, and belting may be taken as double that of the high-speed machine. Then come the questions of efficiency, flexibility, and durability.

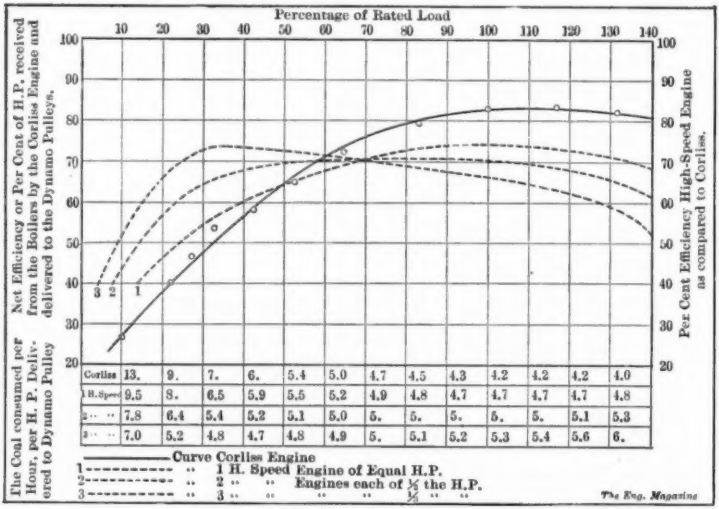
TABLE H. AVERAGE PRICE AND SIZES OF CORLISS SINGLE-CYLINDER ENGINES.

Size.	R. P. M.	Horse Power at 80 Pounds. Cut-off.		Horse Power at 100 Pounds. Cut-off.		Price F. O. B. Cars.
		1-5.	1-4.	1-5.	1-4.	
14x36.....	85	85	100	107	130	$1,700
14x42.....	82	95	112	120	145	1,800
16x36.....	82	105	125	135	160	1,950
16x42.....	78	115	140	150	180	2,000
18x42.....	78	150	175	190	235	2,350
18x48.....	75	160	200	210	250	2,600
20x42.....	75	175	210	225	270	2,600
20x48.....	72	190	230	250	300	2,850
22x42.....	75	210	250	270	325	3,000
22x48.....	72	230	280	300	360	3,300
24x48.....	70	270	320	345	415	4,000
26x48.....	70	315	380	400	485	4,650
28x48.....	68	360	425	460	550	5,150
28x54.....	68	400	480	525	620	5,300
30x48.....	68	410	490	525	630	5,800
30x60.....	62	465	560	600	700	7,000

In the first connection it may be assumed for single-cylinder engines that a total of 3 pounds of coal per horse-power hour will be required by the Corliss, and from 4 to 5 pounds by the high-speed type. Except, however, in the case of large units where direct connection is possible, a considerable part of the gain in fuel economy will be absorbed by power transmission between engine and dynamo. The steam pressure used is an element of considerable importance in fuel economy, as is shown by Curve A representing the results of a series of tests made by me of a 500 horse-power cross-compound. The difference is more marked, naturally, in multiple-cylinder engines where more expansion is possible, but in any case the efficiency increases materially with increasing pressures, within certain limits.



CURVE A. EFFICIENCY OF COMPOUND CORLISS ENGINE OF 500 HORSE POWER.


Percentage of Rated Load
10 20 30 40 50 60 70 80 90 100 110 120 130 140
Net Efficiency or Per Cent of H.P. received from the Boilers by the Corliss Engine and delivered to the Dynamo Pulleys.
The Coal consumed per Hour, per H. P. Delivered to Dynamo Pulley
Per Cent Efficiency High-Speed Engine as compared to Corliss.
100 90 80 70 60 50 40 30 20
3
2
1
Corliss 13. 9. 7. 6. 5.4 5.0 4.7 4.5 4.3 4.2 4.2 4.2 4.0
1 H.Speed 9.5 8. 6.5 5.9 5.5 5.2 4.9 4.8 4.7 4.7 4.7 4.7 4.8
2 " " 7.8 6.4 5.4 5.2 5.1 5.0 5. 5. 5. 5. 5. 5.1 5.3
3 " " 7.0 5.2 4.8 4.7 4.8 4.9 5. 5.1 5.2 5.3 5.4 5.6 6.
Curve Corliss Engine
1 " 1 H. Speed Engine of Equal H.P.
2 " 2 " " Engines each of ½ the H.P.
3 " 3 " " " " ½ " "
The Eng. Magazine

CURVE B. EFFICIENCY OF HIGH-SPEED ENGINES BELTED DIRECT, AS COMPARED WITH THE CORLISS ENGINE DRIVING SHAFTING AND BELTS.

TABLE I. CORLISS COMPOUND CONDENSING ENGINES.

Capacity Horse Power.	Speed, Rev. per Minute.	Steam Pressure, Pounds.	High Pressure Cylinder.	Low Pressure Cylinder.	Stroke.	Cost.	Foundation and Erecting.	Weight Complete, pounds.
200	80	100	14x28x42	18x34x42		$4,565	$1,050	60,000
300	75	100	18x34x42	20x38x48		5,700	1,025	85,000
400	75	100	20x38x48	22x42x48		7,300	1,250	110,000
500	75	100	22x42x48	24x46x48		8,480	1,400	140,000
600	75	100	24x46x48			10,100	1,675	170,000
200	80	120	13x26x42			$4,465	$1,050	60,000
300	75	120	16x32x42			5,500	1,025	85,000
400	75	120	18x36x48			7,100	1,250	110,000
500	75	120	20x40x48			8,280	1,400	140,000
600	75	120	22x44x48			9,900	1,675	170,000

The largest factor, however, in determining the engine to be used is the load to be carried. The load curve, which may be anticipated very approximately, should be studied most carefully. Curve B represents the relative performance of high-speed and Corliss engines operating under similar conditions, platted from data secured by Mr. B. J. Arnold. It will be observed that the efficiency of the high-speed is greater up to about 60 per cent of the rated load, beyond which point the advantage gained by the superior steam distribution of the Corliss is increasingly marked. From these curves, which are characteristic, it will be apparent that, other things being equal, the Corliss is better adapted to loads exceeding the rating, whereas the use of the high-speed is advisable for loads varying within the rated capacity. Aside from the matter of type, the question of number and size and units must be determined from the general, regular fluctuations of the load curve during the twenty-four hour or other daily run.

The commercial sizes of Corliss engines, the usual speed, horse power at 20 and 25 per cent cut-off, at both 80 and 100 pounds pressure, together with the average price F. O. B. cars, are indicated in Table H. The prices will, naturally, vary with different makes and from time to time with the general fluctuations of the market, a comment which applies also to Table J, page 320, representing in addition the average cost of the foundations, piping, and erecting and of the heater, feed pump and injector with connections. Table I shows the horse power, speed, cylinder dimensions, and cost of compound Corliss condensing engines (including condens-

TABLE J. PRICE, CORLISS SINGLE-CYLINDER ENGINE, SET AND CONNECTED.

Size of Cylinder.	Horse Power 80 Lb. ¼ Stroke.	Cost of Engine.	Cost of Foundation.	Cost of Erecting.	Cost of Piping.	Total Cost.	Approx. H.P. of Engine.	Heater.	Feed Pump.		Injector.	
								Price, Brass Tubes.	Price, Pump Alone.	Price, with Connections.	Price, Injector Alone.	Price, with Connections.
14x36.....	100	$1,700	$275	$175	$165	$2,315	20	$47	$70	$84	$20	$77
14x42.....	110	1,800	300	200	175	2,475	35	74	80	93	20	82
16x36.....	125	1,950	325	210	180	2,665	60	107	80	140	20	109
16x42.....	140	2,000	350	225	190	2,765	70	134	127	190	28	110
18x36.....	155	2,150	375	240	200	2,965	80	134	127	196	28	111
18x42.....	175	2,350	400	250	210	3,210	100	161	127	196	30	126
18x48.....	200	2,600	425	260	220	3,505	110	161	127	196	30	135
20x42.....	210	2,600	500	270	230	3,600	125	200	143	253	30	135
20x48.....	230	2,850	525	275	250	3,900	140	200	143	253	38	166
22x42.....	250	3,000	550	300	310	4,160	150	200	143	253	38	166
22x48.....	280	3,300	600	325	340	4,565	160	332	143	253	38	166
24x48.....	320	4,000	700	375	390	5,465	170	332	143	253	38	166
26x48.....	380	4,650	800	440	560	6,450	200	332	143	268	45	191
28x48.....	425	5,150	900	500	800	7,650	225	332	143	268	45	191
28x54.....	480	5,300	1,050	575	950	7,875	250	...	143	...	45	...
30x48.....	490	5,800	1,200	600	1,070	8,670	300	...	143	...	55	...
30x60.....	560	7,000	1,400	700	1,140	10,240	400	...	187	...	65	...

ers) and their weight and average cost of setting and erecting. The prices given apply to both tandem and cross-compounded engines, the cost of the former being less than 10 per cent lower in smaller sizes and sometimes greater in large sizes. The average erection and total cost of condensers is separately indicated in Table K.

TABLE K. AVERAGE PRICE, CONDENSERS.

H.P. Single Cylinder.	H.P. Compound.	Cost.	Erection.	Total.
40	50	$260	$90	$350
60	100	380	125	505
100	120	490	160	650
120	150	540	175	715
150	200	610	200	810
200	250	670	230	900
250	325	775	250	1,025
320	425	975	325	1,300

The cylinder dimensions, horse power, speed and average cost of high-speed single-cylinder engines of standard make are shown in Table L, which includes also the average cost of the sub-base, foundation, and erecting. Table M incorporates similar figures for high-speed compound engines. This type completes the list of those available for the service in question, to which triple or quadruple-expansion engines are not adapted except in an occasional station of large capacity. Although much progress has been made recently in the development of the steam turbine, its application to this class of service has not as yet become general enough to produce serviceable

TABLE L. HIGH-SPEED SINGLE-CYLINDER ENGINES.

High-Speed Engine—H.P...	50	75	100	125	150	200	250
Size of Cylinder, Inches....	9x10	10x12	12x12	13x14	15x14 / 14x16	18x16	19x18
Steam Pressure	100	100	100	100	100	100	100
Revolutions per Minute....	300	300	290	275	245	225	200
Cost delivered, F. O.B.....	$695	$890	$1,085	$1,260	$1,595	$2,010	$2,800
Sub-Base	45	50	50	70	80	90	250
Engine Foundation	65	75	80	95	110	140	200
Superintendence—Labor ...	70	70	70	70	75	85	100
Handling	10	15	15	17	20	25	35
Total Cost of Engine Set up on Foundation.....	$885	$1,100	$1,300	$1,512	$1,880	$2,350	$3,385

figures for comparison with the records of the older reciprocating types. The first cost of turbines with necessary auxiliaries, including the generator, up to 1,500 kilowatt capacity, ordinarily exceeds that of the corresponding reciprocating apparatus, but for larger units there is a slight difference in favor of the turbine equipment. From the performance records already established, the total operating and

TABLE M. AVERAGE HORSE-POWER AND PRICES, HIGH-SPEED COMPOUND ENGINES.

	Horse-Power at 100 Pounds Steam Pressure.								
	60	80	100	125	150	200	250	300	350	400
High Pressure Cylinder..	8 in.	9 in.	10 in.	11 in.	12 in.	13 in.	15 in.	16 in.	17 in.	20 in.
Low Pressure Cylinder..	13 "	16 "	18 "	19 "	20 "	22 "	25 "	28 "	30 "	36 "
Stroke	12 "	12 "	12 "	14 "	16 "	16 "	16 "	18 "	18 "	18 "
Price	$1,070	$1,300	$1,400	$1,690	$2,145	$2,470	$2,730	$3,380	$3,900	$4,290
Sub-Base	120	120	120	140	140	150	160	200	250	300
Total.....	$1,190	$1,420	$1,520	$1,830	$2,285	$2,620	$2,890	$3,580	$4,150	$4,590

maintenance costs of turbine installations appear to be about equal to those of the reciprocating plants of corresponding outputs, except in the case of very large units, where there is a slight difference in favor of the turbine. The efficiency of the turbine is more nearly constant with varying loads, making it especially adaptable to electric and lighting work, and its greatly reduced floor space and head room requirements make it adaptable where reciprocating machinery could not be installed.

As in the case of the engine, the load curve of the station is the most important factor in determining the general type and even the make of dynamo to be used. The characteristics of each machine under all conditions of operation should be carefully studied and the dynamo which is best adapted to the load to be carried and to the general arrangement of apparatus should be chosen. Although varying somewhat among different makes of the same type, the first cost is of minor relative importance. The accuracy of rating, the general construction, and wearing qualities, should by no means be disregarded. The relation between mechanical and electrical quantities and the equivalent of both in lamp candle power are shown in convenient form in Table N.

The switchboard should be designed to handle the full capacity of the station quickly and safely, and care should be exercised in its insulation and erection. Proper efficiency is as important in the distribution of energy throughout the mains and feeders as in its generation from the coal, which should be selected on the basis of the heat units it contains rather than the pounds avoirdupois it represents.

The accompanying tabulation of rates prevailing in thirty odd representative American cities, taken at random, indicates the trend of progress in municipal lighting. The marked

TABLE N. CONVERSION TABLE OF ELECTRICAL UNITS. (1 AMPERE IN 50 VOLT TRANSFORMER = 1 16 CANDLE-POWER LAMP. 1 AMPERE IN 100 VOLT TRANSFORMER = 2 16 CANDLE-POWER LAMPS.)

Volts.	1,000	2,000	3,000	4,000	5,000	Pressure.
1 Horse Power =	3/5	3/10	1/5	3/20	1/8	Amperes
1 Ampere =	1 2/3	3 1/3	5	6 2/3	8 1/3	Horse-Power
1 Horse Power =	12	11 1/2	11	10 1/2	10	16 Candle-Power Lamps.
1 Ampere =	20	40	60	80	100	16 Candle-Power Lamps.

reduction in rates during the past ten years has resulted both from increased competition and from decreased cost of apparatus and greater economy of operation. In each community special problems are presented, sometimes involving conditions entirely foreign to the actual subject of lighting. Other things being equal, power and light should be produced with greatest economy by private enterprise rather than by changing municipal governments whose available financial resources and general business aggressiveness are more limited.

LIGHTING BY PRIVATE CONTRACT.

City.	Population.	No. of Lamps.	Schedule.	Cost per Lamp per Year. 1896.	1906.
Auburn, N. Y.	31,000	417	all-night	$87.50	$68
Albany, N. Y.	100,000	727	"	150	98.55
Akron, O.	55,000	396	moonlight	77	80
Atlanta, Ga.	125,000	1,002	all-night	120	75
Binghamton, N. Y.	51,000	411	"	109.50	84
Buffalo, N. Y.	400,000	2,892	"	127.75	75
Council Bluffs (a)	25,000	....	moonlight	164.25	70
Clinton, N. Y.	2,000	27	"	....	40
Colo. Springs	12,000	250	"	160	66
Canton, O.	45,000	289	"	70	43
		110	all-night	....	62
Camden, N. J.	84,000	672	"	146	109.50
Cincinnati, O.	326,000	946	"	84	72
		4,504	(overhead)	...	60
Dubuque, Ia.	42,000	389	moonlight	65	64.75
Denver, Colo.	150,000	1,248	"	150	60
Fort Wayne, Ind.	50,000	383	"	125	70
Harrisburg, Pa.	75,000	555	all-night	85.50	47
Indianapolis, Ind.	225,000	1,600	moonlight	85	74
Leavenworth, Kan.	25,000	107	all-night	96	84
Manchester, N. H.	70,000	600	"	136	90
Mobile, Ala.	50,000	287	moonlight	76.50	75
Quincy, Ill.	40,000	400	"	75	54.50
Rochester, N. Y. (b)	200,000	3,200	all-night	104	78 (single)
			"	....	74 (pairs)
Troy, N. Y.	74,000	460	"	....	119.50
Terre Haute, Ind.	60,000	500	"	70	70
Washington, D. C.	327,000	990	moonlight	182.50	85
			Average	110.70	89.00

(a) Plant located in Omaha, which city is also supplied.
(b) Water power. New contract dating from July, 1907, at $57.95.

AVERAGE COSTS OF LIGHTING BY ARC AND INCANDESCENT LAMPS UNDER VARIOUS DAILY SCHEDULES.

Length of Time Burning.	Cost 16 Candle-Power Lamp per Hour.	Cost 2,000 Candle-Power Arc per Hour.	Cost 1,200 Candle-Power Arc per Hour.
½ Hour each day	$2.00	$0.16	$0.14
1 " " "	1.12	.08½	.07¼
2 Hours " "	.62	.05	.04¼
3 " " "	.46	.04	.03½
4 " " "	.37	.03½	.03
5 " " "	.32	.03	.02½
6 " " "	.28	.02¾	.02¼
7 " " "	.26	.02½	.02⅛
8 " " "	.25	.02¼	.02
9 " " "	.24	.02⅛	.01⅞
10 " " "	.22	.02	.01¾

The experiment of municipal ownership of lighting properties which has now been quite extensively tried has not proven actually successful. Some few municipally operated plants have produced current continuously at comparatively low cost, but in most cases the properties have ultimately fallen, through political changes, into the hands of incompetents—with disastrous results. In some instances honest management has been maintained, but such vital elements as depreciation have been wholly unprovided for during the period of apparently successful operation, resulting in impaired service and in greatly increased operating costs, and in some cases in the abandonment of plants.

Statistics show that the electric-lighting plant, if properly designed, installed, and managed, offers opportunities to the private owner for large returns on investment, and as a municipal institution, a means of reducing materially one of the largest items of city expense. On the other hand it affords unlimited chances in operation for numerous small leaks, which, taken in the aggregate, may easily counteract the elements of efficiency in design. Reports covering a large number of plants throughout the United States and Canada show that 12.6 per cent are losing money, that with 10.8 per cent the receipts barely cover operating and fixed charges, and that dividends of from 2 to 50 per cent are being earned by the remaining 76.6 per cent.

The elements to be considered are many, but it is to be remembered throughout the design, construction, and operation of the lighting plant that the aggregate efficiency to which each element must be made to contribute in maximum degree, is to be measured ultimately in commercial units, whether the stockholders appear as individuals or as organized members of an urban community.

A REVIEW OF THE WORLD'S TIN-MINING INDUSTRIES.

By A. Selwyn-Brown.

THE steady rise in the value of tin and the comparatively slow expansion of the world's output of tin ore have given rise to apprehension. Substitutes for tin for many industrial purposes have been sought in vain, and the highest chemical skill has been engaged in discovering the most efficient means of diminishing the amount of the metal utilized in tinning processes, as well as in recovering tin from scraps. These fields of research have yielded well and tin is now used with but little waste, while several patented metallurgical processes are successfully employed in recovering large quantities of tin annually from waste tin scrap.

It is well known that tin is the most sparsely distributed of all the useful common metals. Deposits of iron, lead, copper, zinc, and aluminium occur in almost every country, but there are only a few restricted areas in which tin occurs in sufficient quantities to permit it to be profitably mined. Although much capital has been expended in prospecting for tin-bearing ores in the United States and Mexico, little more than traces of the metal have been found. There is not a single important tin-producing mine in operation in any part of North America. Prospecting is still carried on in Mexico, North and South Carolina, and Alaska, with the view of developing tin-mining industries, but the prospects at present are not very promising.

Not only over the vast mineral areas of North America is there an absence of valuable tin fields, but no tin-mining operations of importance are being carried on in Africa, nor, excepting in Cornwall and in a small district in Saxony and Spain, in Europe. Furthermore, some of the districts which have hitherto supplied the world's tin wants are showing unmistakable signs of exhaustion at a not distant date. Notwithstanding these conditions and the complete failure of the attempts to find a substitute for tin, the demand is increasing and must continue to do so in proportion to the growth of the world's commerce and wealth. What, then, is the outlook of the tin-mining industries? It is proposed in this article to review the conditions on the principal

tin-mining fields and to indicate briefly how the world's increasing demands will continue to be met.

The World's Tin Production.

The most important tin-mining countries are the Malay Peninsula, Bolivia, Australia, and England. They rank in importance in the order named. Statistics generally place England above Australia, but it should be borne in mind that the world's greatest tin market is in London and much foreign tin ore is sent to English smelters for reduction and some of it is credited to English production.

The world's tin output in 1906 was estimated at 79,000 long tons and its New York value was 35 cents per pound. During the past three years tin production was vigorously stimulated and the output was as given in the following Table I:

Table I. The World's Tin Production.
(In Long Tons.)

	1904.	1905.	1906.
England	4,132	4,468	4,920
Straits	60,827	58,547	58,438
Australia	4,846	5,028	6,888
Banka	11,363	9,960	9,300
Billiton	3,215	2,715	1,950
Bolivia	11,867	12,500	14,700
Totals	96,250	93,218	96,196

The present value of tin in New York is between 35 and 36 cents per pound, with a good demand and tendency to go higher. The production this year promises to fall a little short of last year's.

In the above table the prominent position occupied by the Straits Settlements as tin-producing centres is plainly emphasized.

The Straits Settlements.—The Straits Trading Company, an English corporation the shares of which are largely in Chinese hands, has a large tin smelter at Singapore which reduces the largest part of the tin mined in the Orient, and much of the tin credited to the Straits is really mined over a larger area than the Malay Peninsula.

The tin fields in the Federated Malay States have been mined regularly during the past three centuries. At the present time they produce between 40,000 and 50,000 tons of tin per annum. The returns last year amounted to 48,616 long tons as compared with 50,991 tons in 1905. The principal mines are in Perak, Selangor, Negri Sembilan and Pahang. There are discrepancies between the Tin Mining Association's figures and those furnished by the Government. The latter estimate of the production of these States in the past four years is given in Table II.

TABLE II. MALAY STATES TIN PRODUCTION.

	1903.	1904.	1905.	1906.
Perak	29,014	29,527	29,711	28,988
Selangor	18,926	19,978	19,272	17,864
Negri Sembilan	5,684	5,643	5,662	5,172
Pahang	1,684	1,877	2,320	2,294
Totals	55,308	57,025	56,965	54,318

The Malay tin-bearing formations are chiefly shallow placers. Tin veins occur in granitic rocks in some of the mountain ranges and a few small veins are being worked. They are, however, low-grade and not very profitable. More than 90 per cent of the ore is won by Chinese and natives, by primitive methods of sluicing and hand panning the surface alluvial soil. The figures in Table II exhibit a tendency of the output to decline. This is due to two main causes, the exhaustion of the easily worked surface deposits and the scarcity of Chinese coolie labor.

In the height of the industry's prosperity the average value of the tin deposits in the Federated Malay States, and in the islands of Billiton and Banka, was about 6 per cent of black tin ore per ton of earth mined. Today the average value of the material mined is not more than 1 per cent.

The tin-mining leases are chiefly owned by Chinese merchants residing in Singapore, Penang, and other important trading centres in the peninsula, or by Chinese companies domiciled in China. Chinese coolies, expressly recruited in China for the work, do most of the mining and washing of the ore. Although China possesses a large population, experience has demonstrated very clearly that only a comparatively small proportion of the strong and virile single men competent to undertake steady laboring work are prepared to leave their homes and brave the hazards of distant emigration, in response to the call for their services in foreign lands. Migration has always been distasteful to the Chinese, who are essentially a home-loving people and possess a rich and beautiful country. Industrial conditions in their homeland, too, have been such as to detain them in China. During the past few years there has been a large measure of prosperity in Oriental countries. China has enjoyed a good share of this and greatly extended the national railroads, canals, and harbor and river improvements which absorbed a large amount of labor. Owing to the steadiness and reliability of the Chinese coolie, there was strong competition in securing his services for Oriental countries adjacent to China. In addition to the Oriental demand, the South-African gold fields absorbed several hundred thousand Chinese labor-

ers, and large numbers were introduced by the western railroad companies into the United States either directly or by way of Hawaii, Mexico, and Canada. In consequence of the shortage of labor in the Malay States which was caused by these conditions the tin-mining industries have been severely crippled. Barely half the coolies required by the mines are obtainable. The miners take advantage of the mine owners' embarrassments and frequently go on strike. Such troubles have lately led to a great extension of the leasing system, and mine owners are letting out large portions of their properties to coolies on annual leasing agreements. This system, experience has shown, is one of the most effective yet devised for keeping the mines in operation during the present dearth of labor.

SIAM.—In addition to the tin fields of the Federated Malay States, valuable tin deposits are worked in adjacent countries including Siam, Annam, Cambodia, Burma and China. The mines in Siam and China are the largest of these outside producers. Tin is being mined in the valley of the Nam Sak river in northern Siam, at Bangtaphan, Lakon, Ratburi, Kelantan, Tringannu and other localities on the east coast, and at Puket, Kedah and Renong on the western coast. The present annual output is about 5,000 tons. The tin-mining industries of Siam, according to the recent reports of geological investigation, are capable of undergoing a large expansion.

CHINA.—Large quantities of tin ore have been annually mined in China for many centuries, but as no statistics are kept it is difficult to determine the present position of that country as a tin producer. There is no doubt, however, that the annual production of tin is still large. The principal tin-mining centers are in the provinces of Yunnan and Kwangsi. The annual yield of the Yunnan mines is estimated by the local authorities at from 5,000 to 6,000 tons.

AFRICA.—The occurrence of tin ore has been reported from several districts in Africa and it is possible that as that country becomes developed, tin mining will become one of its industries. Specimens of tin ore have been discovered in the Congo Free State in the vicinity of the Lualaba river. Alluvial, or placer, tin deposits were found by an exploring expedition in the Uwet district in Southern Nigeria in 1905, and prospecting operations carried on by an English company at Bautchi, in Northern Nigeria, resulted in the discovery of several low-grade tin-bearing veins in granite country. Reports of a favorable nature regarding the prospects of these deposits have been made by experts and there are prospects of European capitalists being induced to develop them.

EUROPE.—Notwithstanding the high prices ruling for tin during several years past, the tin production of Cornwall fails to exhibit signs of any important expansion. But fresh capital is being attracted to Cornish tin-mining investments; a number of old mines are being reopened and are resuming mining operations, and mines like the well-known Dolcoath, that have produced regularly for many years, are now being worked to their utmost capacity and vigorously developed. The mines of Cornwall are reported to have produced 7,201 tons of tin ore last year, which on being smelted yielded a little under 5,000 tons of metallic tin. This is about the same amount as they produced in 1905.

Several English and French companies have been formed to rework some of the old Spanish tin mines. The most important of these is the Sultana mine in the province of Orense. In this property there is a large vein carrying tin in association with arsenical pyrites. The assay value of the ore is low and the tin is difficult to reduce owing to the presence of the sulphides.

SOUTH AMERICA.—The most promising tin deposits in South America are in the Andean districts in Bolivia. In the past six years a large amount of English, American, and Chilean capital has been expended in developing the Bolivian tin mines, and as a result tin exports to Europe are rapidly increasing. The amount exported last year was 14,700 tons. This ranked Bolivia next to the Malay States in tin production.

Tin mining is pursued in Bolivia under many disadvantages. The mines are mostly high up in the Andes in almost inaccessible positions, the climate is exceptionally bad owing to the high altitudes, mining titles are insecure through the mal-administration of the law, water for mining purposes is difficult to conserve, and mining labor is inefficient and very difficult to obtain.

The most important deposits are in the Quinsa Cruz district, and are situated at an altitude of 15,500 feet above sea level. At such an elevation only native Indians can do laboring work, and they are few in numberes and are disinclined to work steadily, even under the stimulation of high rates of pay. It is only with difficulty that men brought up in low-lying districts can walk about on the mines in this district. The ore deposits occur chiefly in porphyry veins traversing a series of clay schists, bearing a somewhat strong resemblance to the famous Mount Bischoff deposits in Tasmania. The value of the ore varies between 3 and 10 per cent of metallic tin per ton. An extensive and expensive metallurgical plant is required.

The Chorolque mine is at present the largest producer in the Quinsa Cruz district. It is yielding about 200 tons of tin per month. Large mining and metallurgical plants are being installed at the Llallagua, Potosi, and Monte Blanca mines, and these are expected to become important producers. The Oploca and Chocaya mines are also increasing their production, and the Bolivian tin-ore production consequently promises to reach record figures during the next few years.

TASMANIA.—The greatest individual tin producer in the world is the Mount Bischoff mine at Waratah, Tasmania. This famous mine has been in continuous operation during the past thirty-four years, and during that period the shareholders in the company owning it have received $10,395,000 in dividends, or $866 per each original $5 share. Hitherto the ore won from this mine came from a purely detrital deposit formed as the result of the weathering and decay of a series of stanniferous quartz- and topaz-porphyry dikes traversing a series of greatly metamorphosed schists which form the summit of Mount Bischoff, a prominent hill lying between the Waratah and Arthur rivers. This detrital, or placer, deposit has nearly been worked out. Lately the monthly yield of tinstone has been reduced from 100 tons to 70 tons. At a recent meeting of the directors of the company in Launceston, Tasmania, the mine manager stated that he will be able to keep the mill supplied with sufficient amount of placer material to yield an average of 70 tons of tinstone per month for the next seven years. He will be able to do this by cleaning up the old workings, mining away material left standing to support old workings, and re-picking material from the dumps. At the end of seven years a different class of material will have to be dealt with.

At the same meeting it was determined to re-form the company. The present company's charter was drawn for a period of thirty-five years. This term will elapse early in 1908. It is proposed to draw up a new charter for a period of one hundred years and enlarge its scope so that the company may purchase or operate other tin-mining properties on lease.

In addition to the detrital deposits, the Mount Bischoff mine contains inexhaustible low-grade sulphide tin deposits in numerous quartz veins and in quartz- and topaz-porphyry dikes which run throughout the company's leases and traverse the West Bischoff and other adjoining mines. These tin-sulphide veins also carry arsenical pyrites in large quantities, making mining dangerous through the frequent firing of the workings, and greatly complicating

the metallurgical treatment of the ore. Large sums of money have already been expended in experimenting with metallurgical processes for treating low-grade tin-sulphide ore, but an efficient and cheap reduction process is still being sought.

Adjacent to the Mount Bischoff there are several smaller tin mines in successful operation, and alluvial tin is being won from the Waratah and Arthur rivers in the vicinity of the mines. Tin mining is also being vigorously pursued in many other districts in Tasmania. The metal occurs practically all over the island and many of the mines are well established and profitable. The Blue Tier mines, situated on the west coast of the island on the range of mountains bearing the same name, are the most noteworthy after the Mount Bischoff mine. The ore is found in a series of quartz veinlets varying in width from a mere thread up to several inches, which traverse granite deposits and are known to miners as "stockwork" tin formations. The ore is of low-grade, but it has been amply shown that when the mines are operated on a large scale with suitable machinery the tin can be profitably won. The Anchor and Australasian mines are the chief producers. The average value of the ore worked is 5 pounds of black tin per ton of granite. The total cost of mining, concentrating, and dressing the ore is 75 cents per ton. The Anchor mine is worked as a quarry, employs 120 men, and yields about 20 tons of tin per month. The Mount Lyell Company has recently acquired a large number of tin-mining leases in the Blue Tier field and is making preparations for mining tin on a large scale. It is very probable, also, that the Mount Bischoff company will soon undertake the development of a number of the smaller mines on the field.

The Heemskirk tin field, situated between Mount Lyell and Mount Bischoff, is at present attracting much attention. It is an old field, but has hitherto been worked on a small scale only. Tin occurs in the mines in the form of veins, many of which are very rich. The Cumberland, Orient, and St. Clair mines are now in course of development. The ore in these mines runs from 3 to 10 per cent of tin per ton.

There are many placer tin mines in operation in Tasmania, including the Briseis and New Brothers Home, and two successful tin dredges.

The Briseis and New Brothers Home placer mines are owned and operated by an English company. Their combined output last year was 1,408 tons of black tin, containing 1,031 tons of metallic

tin. To this amount, the Briseis contributed 912 tons valued at $840,615. It is estimated by the company's engineers that the tin-bearing drifts at present developed in the Briseis mine exceed 2,000,000 cubic yards of ore.

AUSTRALIA.—The tin production accredited to Australia last year amounted to 9,000 tons; but it was doubtless much larger, as the estimates are based chiefly on export statistics and take no account of the tin used in local industries. One mine alone, the Vulcan, produces between 6,000 and 7,000 tons yearly. Tin ore is dispersed over a wider area in Australia than in any other country, and there is little doubt that when capital is invested in the tin mines Australia will rapidly take rank as the leading tin-producing country. The principal mines now in operation are in the eastern states of New South Wales and Queensland and in West Australia.

The most valuable tin mine in New South Wales, and one of the greatest on the continent, is the Gundle mine, the property of the Gundle Tin Mining Company, Sydney. The mine is situated on Mount Gundle, a prominent peak on the North Coast range, about 30 miles west of Port Macquarie, and a little to the south of the Hastings river. The vein is 30 feet in width and averages over 10 per cent tin. The Conrad mine, near Inverell, in the New England district, is another important mine. It is also a vein-mining property averaging about 5 per cent tin. The ore, however, is complex and carries good values in silver, copper, lead, and zinc, in addition to tin. At present some trouble is being experienced in metallurgically dealing with the ore.

A feature of the New South Wales tin-mining industry is the great success of the tin dredges. At present more than thirty dredges are successfully engaged in tin mining in New South Wales, and about a dozen are operating, or are in course of construction, in Queensland. Both centrifugal and bucket dredges are engaged in tin mining, one kind being more efficient in one class of work and the other in another. As a rule the tin-bearing formations are composed of pure sand which has been derived from the decay of stanniferous granites. The centrifugal dredges are found to give the best results in such a material; but where the ground is hard and clayey, bucket dredges are the best. The average value of the material treated by the dredges is 2.5 pounds of tin per cubic yard, valued at 75 cents. Mining amounts to 10 cents per cubic yard; so the resulting profit is about 65 cents per yard.

The tin-mining industries in New South Wales are undergoing a

rapid expansion and there are indications that European capitalists are beginning to recognize their value.

Several successful tin-mining dredges are operating on the Stanthorpe tin field in Southern Queensland. The greatest activity in that State, however, is on the Herberton tin field in North Queensland. The famous Vulcan mine, at Herberton, is yielding between 6,000 and 7,000 tons of tin per annum and paying its fortunate owners large dividends. The Smith's Creek and Stannary Hills mines are also developing into large regular tin producers. During the past few months a large and very rich tin vein has been cut in the Tornado mine, at Irvinebank and this property promises to become as important a producer as the Vulcan. Considerable progress is being made on the tin fields in the far north of Queensland and in the Northern Territory.

The principal tin-mining centres in West Australia are in the Greenbushes district, on the north coast. The tin-mining industries there are giving employment to about 1,000 men at present, but English capital is being directed to the field and within the next few years the industry promises to expand largely and afford employment to a much greater number of miners.

CONCLUSION.—The principal tin-producing centres have now been cursorily surveyed. It will be noticed that the active tin-mining fields are few in number, and generally speaking, are not in a very healthy condition, notwithstanding the high value of tin and the large existing demand for it. The alluvial deposits in the Malay States are approaching exhaustion. The deposits in the Dutch East Indies, on the islands of Banka and Billiton, are in a similar position. Scarcity of coolie labor is severely handicapping the tin-mining industries in those centres. Bolivia is advancing its production, and for some years to come will maintain a large annual output. Finally, however, consumers of tin will have to depend upon Australia and Tasmania for the principal part of their tin supplies. Africa may develop into a tin-mining country of importance. It is possible, also, that some of the mountain districts of South Eastern Asia may become centres of profitable tin-mining enterprises, and capital may open up tin-bearing veins in some of the old alluvial tin fields in the Malay States.

The proved tin fields of Australia, however, are ample to supply the world's wants, and their slow development is due solely to the scarcity of capital. As the demand for tin becomes still keener this will, doubtless, be satisfactorily remedied by the introduction of European capital into tin-mining enterprises.

EDITORIAL COMMENT

THE discussion of the Quebec Bridge disaster abstracted from *Engineering News*, which appears in our Review pages opposite, probably strikes very close to the true explanation of the failure. At the moment of the wreck, indeed, A9R rather than A9L seems to us to have led in the collapse; but if so, it would appear to be because the partial failure of the left-hand truss some days previously had already thrown an undue proportion of the load upon the right-hand member—a proportion which it bore until the "last straw" was added, and then, by sudden buckling, threw back again upon the already crippled A9L.

Examination of the wreck suggests fear that the compression members generally were under-proportioned; but whether or not that impression is well founded, even the most casual inspection excites amazement—almost consternation—at the comparative lightness of the latticing and the insufficiency of the riveting. The whole system by which the huge built-up members ought to have been connected, bound, and stiffened so as to act as units, was —flimsy; that is the only adequate word. As *Engineering News* shows, by reducing the scale of the latticing protionately down to the case of a strut of ordinary dimensions, the provision made in these "huge columns" did not at all reach the limits of practice common in the case of trusses of very moderate size. Under such circumstances it does not seem necessary to appeal to any mystery of knowledge as to the action of materials under stress, lying in that range beyond experience but within experiment in which this structure was projected. The great vision by which vast engineering work has heretofore been carried safely into the region where "accepted formula" must be carried forward and enlarged, seems to have been lacking. The most deplorable thing is that it was not swift enough to perceive error and to act in time, even when deadly danger was clearly revealed in the incipient collapse of the work.

* * *

THE New York street-railway scandal follows the insurance scandal, the Mercantile Bank shame jostles both, and one wonders indeed how many more of our once-great and honored captains of industry belong to the thieves' company. Europe is not to be blamed for a searching distrust of American "finance," nor America for dallying with almost any political nostrum which promises honesty in high places. But property has always tempted the plunderer, and he will always steal when and what he can, whether the opportunity is given him by the trusting vote of a spellbound citizen electorate, or of a plausibly solicited majority of stock certificates. The strongest deterrent to the thief is light. Publicity makes it much harder for him to get away with the goods—or if he has got away with them, it at least (providing there is still a vigorous, healthy public opinion on the subject of keeping stolen property) spoils most of his pleasure in the fruits of his crime. State ownership at best would but substitute one set of frailties for another. Public examination and inspection—not retrospective, but current and continuous—could far more easily be kept in incorruptible hands. The very conditions make corruption far less probable. This way lies salvation.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE STRENGTH OF LARGE COLUMNS.

A DISCUSSION OF THE NECESSITY FOR MORE ACCURATE DATA ON WHICH TO BASE THEIR DESIGN, AS EVIDENCED BY THE FAILURE OF THE QUEBEC BRIDGE.

Engineering News.

LAST month we reviewed in these columns an elaborate analysis, taken from a number of *Engineering News*, of the available evidence as to the point of initial failure of the Quebec bridge. The deduction made from the facts available at the time the article was written was that the failure of some compression member in the anchor arm of the cantilever was the initial cause of the wreck and that all the indications pointed most strongly to chord A9L. Subsequent investigations have served only to offer additional evidence as to the correctness of this theory, which seems now to be generally accepted as the true explanation of the cause of the disaster. *Engineering News* has since extended its analysis in an endeavor to determine why this member should have failed and reaches the conclusion, suggested in the former article, that our deficient knowledge of the strength of large columns was primarily responsible for the disaster.

It is first pointed out that there are only two possible explanations of the failure of chord A9L. The first is that this member had some inherent weakness due to defects of manufacture or to accident in handling and transportation; the other is that it was typical of all members of its class, and that while it was the first to fail, the other members were in no less serious danger. All the evidence points to the latter explanation as the true one. It is admitted that chord A9L had suffered accidents of one sort or another in handling and transportation. It is inconceivable, however, that it could have been put into the structure in a seriously damaged condition without attracting notice, or that the bend discovered in it just before the wreck could have been of long standing.

"And now let us proceed a step farther. Study of the wreck at the bridge site points strongly to the conclusion that when lower-chord member 9A in the left truss was at the point of failure, *some compression member in the opposite truss was in almost the same condition.*

"To show this, let us for a moment assume the contrary case and suppose that 9A was the only weak member in the bridge and that all others had the margin of safety for which they were designed. If this had been true, then the left-hand truss would have failed appreciably before the right-hand. Destruction of the cross-bracing would of course quickly wreck the left truss also; but almost certainly it would have held together several seconds longer than the left-hand truss and would then have gone down on top of the other. At least, the wreck would bear evidence of such a sequence in failure of the two trusses.

"What the wreck actually indicates, however, is that the failure of the two trusses was probably nearly simultaneous. If anything, the wreckage of the anchor-arm lies to the right of the center line of the bridge; its center of gravity in falling appears to have gone eastward, perhaps 8 to 10 feet.

The bottom chord of the left-hand truss is plainly visible near the whole length of the anchor-arm. The bottom chord of the right-hand truss is buried under wrecked web members nearly all the way.

"If chord member 9A on the left failed first, then almost simultaneously a member in the opposite truss, perhaps the chord member directly opposite, went, too. It went because it was also overloaded, and the stresses produced by the falling truss opposite almost instantly buckled it like its mate on the other side.

"Here we have at least two compression members designed for a compression stress of 24,000 pounds per square inch and failing at a load of some 16,000 pounds, not more than half the elastic limit of the metal in tension. Why did these members fail? It was not weakness at the ends. The construction of these members at the joints was worked out with greatest care to properly distribute the stress and the workmanship was of the highest excellence. It was not faulty material. The steel of this bridge has been subjected to a more terrible ordeal than any testing laboratory ever devised. It has been torn, twisted, bent and crushed in every possible way; but its fractures indicate it to be throughout just the ductile, homogeneous metal which the designers aimed to secure. Further, even brittle material would not explain a failure under a compression by static load. We may admit perhaps a possibility that incomplete field riveting may have contributed to weaken the members; but from any evidence thus far uncovered, it does not seem to have been in any degree the chief cause.

"All other causes of failure being found untenable, one is forced to the conclusion that these members failed from lack of stiffness. The more one studies this huge scrap-heap on the south shore of the St. Lawrence, the more one is impressed with the comparative weakness of the means adopted by the designers to stiffen and bind together the massive plates of which these columns were built up into a single member.

"Let us look for a moment at the construction of the compression chord members of this bridge. They consist substantially of four massive plate webs or girders, each made up of four rolled plates, stitch-riveted together to form one built-up plate nearly 4 inches thick. Each of these is finished with an angle at top and bottom, and these four long thin girders are supposed to be stiffened and bound together so as to act as one member by latticing on the top and bottom made of 4 × 3 inch 8½ pound angles.

"The point to which we would direct attention is the small size of the angles which are supposed to lattice these four massive webs into one member compared with the size of the webs themselves and, of course, of the load the whole member has to carry. Near the ends of the member, it is true, a long, heavy cover plate replaces the latticing angles; and it is very noticeable in the wreck how vastly more efficient a plate covering is than angle latticing to hold members in place against heavy punishment.

"Of course it may be urged in defense of this design that comparatively little material is needed to hold members rigidly in line when subject to direct compression. In theory this is true; and it would be true in practice if all the parts of a compression member were absolutely true, free from all initial strain, and if the load upon them were applied with absolute exactness. Such conditions do not and cannot obtain with even the best workmanship. All our plates and angles have to be straightened after coming from the rolls. Shearing, punching and riveting all set up initial stresses. Every joint in our structural work is far from mathematical perfection. There is no doubt, then, that the stiffening lattice or web that binds the parts of a strut together ought to be in proportion to the parts which it holds.

"But the evidence that carries most conviction is the evidence of actual trial, and it is this evidence that indicates the latticing of these chord members to be inadequate. Lower-chord member 9A at Quebec was found bowed out of line on Aug. 27 *because the latticing and the rivets that held it were not strong enough and stiff enough to hold the four webs in place and make them act together.* And if the latticing was not strong enough for its duty here—even granting previous injury—was it strong enough for its duty elsewhere?

"The Quebec bridge, like any other bridge, was no stronger than its weakest main member. All its main compression members—posts and chords alike—were made up of thin webs which independently of each other were too flexible to have borne any end compression of consequence. All of them, therefore, depended absolutely for their rigidity and stiffness to resist compression without flexure and failure upon the lattice bars by which they were connected, and these in turn upon the rivets that held them. The same thing is true, undoubtedly, of all our struts and columns in all our bridges and buildings; but it is well to have the fact brought clearly and forcibly home to the comprehension of every engineer who has anything to do with structural work.

"Was this latticing on these huge columns strong enough for the work it had to do? What does the profession know about the stresses in column latticing? Where in engineering literature has its proportioning been carefully and soundly discussed? If practical experience shows, as may be claimed, that ordinary practice in latticing is good and safe, how shall we safely bridge the gap between the strut in an ordinary bridge designed to carry a load of say a million pounds and these huge columns carrying more than twenty times as much?

"Should the latticing be proportioned to the cross-section of the members which it holds in line? Then these 8½-pound angles on a member with 781 square inches cross-section would correspond to single lacing bars only 1 inch × ⅛ inch on a strut one-fortieth as large, say of 20 square inches cross-section, or a pair of 15-inch 33-pound channels.

"Again, how should the proportions of lattice-bars be varied with the variation in the length of the member? Are the lattice-bars to be considered like the web-members of a truss, since their office is to hold the several ribs they connect from bending? If so, the long column like the long span bridge would seem to require latticing heavy in proportion to the column's length.

"Still again, what relation does the great depth of these webs bear to the security of the latticing? We know that a thin flat plate has little stiffness to resist end compression. In broad plates secured by latticing only at their edges and subjected to end compression, is there possibly some deforming action near the center of the plate which does not occur in the comparatively narrow plates used in ordinary columns?

"What, if any, were the computations by which the designers of this bridge assured themselves of the sufficiency or supposed sufficiency of this latticing? On what assumptions were their computations made and can these assumptions bear the criticism of the profession?

"Such are some of the questions which surely arise wherever engineers are studying the failure of this huge structure; and an answer to which cannot be given without venturing on debatable ground. And to answer with entire certainty these questions which are troubling the profession we must have something more and better than mere computations of the stresses in column latticing, important though these are at the present juncture. It will not be possible, we believe, to reassure either the public or the engineering profession as to the actual strength of such huge columns until actual tests are made upon them. . . .

"How many thousands of engineers, as they realize at times the heavy responsibilities that they carry for the safety of life and property, have longed for records of tests of full-size columns such as they are obliged to use in their works. The designers of the Quebec Bridge had to build up a column of steel plates and shapes to carry a load at the ninth panel of the lower chord of 22,000,000 pounds. They had for a guide the accepted theories of column stresses based on tests made a generation ago on columns of trifling dimensions.

"We do not mean to indict the soundness and general reliability of the accepted column formulas, for members of ordinary size where past experience serves as a check and safeguard. We do believe, however, that for the columns of massive dimensions such as are being more and more called for by present-day demands in bridge and building construction, theory needs to be supplemented by actual tests."

It is suggested that money should be forthcoming immediately to build a testing machine large enough to investigate these matters.

FOREST PLANTING FOR RAILROAD PURPOSES.

DETAILS OF THE WORK UNDERTAKEN BY THE PENNSYLVANIA RAILROAD TO SECURE A FUTURE TIMBER SUPPLY.

E. A. Sterling—Engineering News.

IN a review in these columns in THE ENGINEERING MAGAZINE for May, 1907, some details were given of the enormous consumption of timber, particularly for ties, by the railroads of the United States, and it was pointed out that the rapid exhaustion of the forest reserves of the country imposes upon all consumers of timber the necessity for economy in its use. The increasing scarcity of all grades of timber and the steady advance of prices are phenomena of long standing, but until recently they have had little or no effect in influencing individual consumers to use less wasteful methods, and practically the whole burden of the task of conserving and replenishing the timber supplies of the United States has fallen upon the Forestry Departments of the State and National governments. It is encouraging, however, to note that in the last few years some of the larger corporations of the country have begun the planting of forests on waste and unproductive land in order to ensure a future supply of timber for their own use, and the immediate future will no doubt see a large extension of private enterprise in this direction. The following abstract gives some interesting details of the forest planting by the Pennsylvania Railroad as described by their forester, Mr. E. A. Sterling, in a recent number of *Engineering News*.

"The Pennsylvania Railroad has probably done more forest planting than any other eastern corporation, and some of the cost figures on this work may be interesting, and possibly give an incentive for similar work by other land-owning companies.

"The work was started in 1902 with the object of determining the feasibility of utilizing, for the production of timber suitable for cross-ties and fence posts, land acquired and held for railroad purposes. In straightening and widening the main line, and to avoid expensive overhead or undergrade crossings and damages by reason of stream or drainage interference on new low-grade lines, the company in many instances purchased entire farms. These farms, ranging from 20 to 200 acres in extent, are the lands on which planting has been done.

"Between 1902 and 1907 black locust was the species exclusively used, and during this time 1,679,320 trees were planted. The average cost of planting was a little less than $20 per 1,000, but as the work was experimental and entirely new this cost cannot be considered representative. In the spring of 1907 it was decided to try other species, since it was found that the 'locust borer' was working serious injury in the plantations established, and that the locust was not adapted to all the situations available for planting.

"The following table shows the various species and the total number of trees planted in the spring of 1907:

Species.	No. of seedlings planted.
Red oak	252,154
Black locust	175,716
European larch	6,970
Pin oak	4,570
Scotch pine	3,500
Tamarack	3,000
Chestnut	2,316
Total	448,226

"The 448,226 trees listed above were planted during April and May at three points on the main line between Harrisburg and Altoona, on ten typical farms which were acquired for railroad purposes. The cost items represent, with a fair amount of accuracy, the expense of private planting on such scattered areas and under existing labor conditions. At Altoona, where Italian laborers were employed and the trees planted 6 by 6 feet apart in small holes prepared with a mattock, the cost was $5.12 per 1,000. This cost increased to a maximum of $7.85 at Mt. Union, where American labor was used and the trees were set 4 to 6 feet apart in furrows plowed 5 feet apart; while at Newton Hamilton, where the same crew planted in furrows, the cost dropped to an average of $4.82 per 1,000, the expense of

furrowing being included in both cases. The difference in cost was due largely to extra expense at Mt. Union in clearing the ground from brush, and in resetting fences. Marked variations in the cost of planting may always be expected, but the average of $6.04 per 1,000 may be considered a fair approximation of the expense for reforesting old fields where there is not much brush to hinder operations.

"The seedlings planted ranged from one to three years old, and were purchased from commercial nurseries at an average cost of $5.25 per 1,000, making the total cost $11.29 per 1,000. With the usual spacing of 6 by 6 feet, or 1,210 trees to the acre, the cost of such work per acre would be about $15. The Pennsylvania Railroad has established a large forest nursery at Hollidaysburg, near Altoona, in order to grow its own plant material. With home-grown seedlings, the total cost of establishing forest plantations should not exceed $10 or $12 per acre, if the work is done on a large scale.

"In the choice of species, much depends on the character of the ground and on the use which is to be made of the timber when mature. A railroad company is naturally most interested in cross-ties and fence posts, and the fastest growing timber suitable for these purposes would be selected. The most desirable trees, however, are often of discouragingly slow growth, which necessitates a compromise between growth and quality; for example, red oak is being planted instead of the more durable white oak, because of its faster growth, and on the assumption that treatment with preservatives will be in general use by the time the trees mature. Scotch pine is being used with the same end in view. In the light of European experience, both red oak and Scotch pine woods, if creosoted, and protected from mechanical abrasion under the rail, will have double the life of untreated white oak. Such species as pin oak and tamarack are used in wet situations, where the more valuable trees would not flourish."

HYDRAULIC POWER IN FRANCE.

DETAILS OF THE EXISTING HYDRO-ELECTRIC DEVELOPMENTS AND OF THE WATER POWERS WHICH STILL REMAIN UNUTILIZED.

Engineering..

A RECENT number of *Engineering* gives an interesting review of the importance of hydraulic power in France. It is estimated that the nominal power developed by steam engines reaches a total of about 8,900,000 horse power, which would correspond to only about 3,860,000 horse power, actually effective throughout the entire year. The following details, therefore, of the possibilities of hydro-electric power development throw an interesting light on the effect the utilization of her immense water powers would have on French industry.

"In France, the power available at different periods of the year in the various water-courses has not been gauged with the degree of accuracy which has obtained in other countries, and it is not possible, therefore, to arrive at an exact figure for the hydraulic power that can be turned to account. The country, however, is favoured in the matter of water-courses and waterfalls, and differences of level in the case of several rivers ensure for these a rapid flow. The rainfall is generally regular, and a constant supply for the hydraulic stations may be relied on. The highest waterfalls are found in the High Savoy, Savoy, Isère, and High Alps districts. In the Lower Alps and the Pyrenees there are also waterfalls that might be utilised, but they are of less importance than those of the former districts. In many other parts of the country there are mountains and hills, among which the valleys act as reservoirs for a number of streams, having an appreciable head of water and a regular flow; such are the central plateau of France, the Jura, the Vosges Mountains, and Normandy.

"Previous to the invention of the steam-engine, the natural sources of power were utilised to some extent, and windmills and water-wheels were frequently met with, distributed over the whole country. The

former have now almost completely disappeared, but water-wheels, on the other hand, are still utilised, the principal reasons for this being that water-power is more reliable than wind-power, and in the second place, the cost of installation of a large turbine plant involves a heavy initial outlay, which requires time to write off. Nevertheless, a number of water-wheel plants which were used mainly for corn-grinding are gradually ceasing running, and are being superseded by modern installations for the production of current for power and light distribution.

"On the non-navigable rivers throughout France there are at the present time 46,000 hydraulic installations of all kinds, the total power available of which is 500,000 horse-power; on the navigable rivers there are 1,500 such installations, with a total of 80,000 horse-power. The very small average power of the installations is due to the existence of a number of water-wheels still running. These are generally in streams in which the head of water is low. Streams capable of giving power at low head of water are generally distinguished by the term *houille verte* (green coal), in contrast to the *houille blanche* (white coal), representing mountain torrents and waterfalls from which power can be derived. The mountainous districts are those in which are found the highest figures in hydraulic power utilised. Thus in the Isère Department alone there are employed about 40,000 horse-power; over 30,000 in Savoy; 22,000 to 25,000 in the Lower Pyrenees; over 20,000 in the High Savoy, and almost the same figure in the Higher Pyrenees. The Departments of the Vosges and Jura show also high figures. The Rhône Department, although it is not in a mountainous district, compares favourably with the preceding, owing to a station at Jonage, which utilises through a canal a difference of level in the flow of the Rhône.

"The first step in the utilisation of waterfalls in France on scientific and commercial lines dates back to 1871, when an installation was put down at the junction of the Valserine with the Rhône. The company was originally a French one, but the undertaking subsequently passed into English hands. At that time the power could not be distributed as is now possible, and the situation of the company was not satisfactory; good results were only obtained in 1898, when a new French company took over the business and generated current for power transmission. When once the movement for power transmission was fairly started, developments were rapid, and particularly in the Alps district, in the valleys of which—such as that of the Romanche—there are successions of generating-stations, one taking the water from the tail-race of a station at a higher level. In the region between the Alps and Lyons, the power utilised in the manufacture of aluminium alone has been increased during the year 1906 by 5,000 horse-power, and that for carbide of calcium production by a like amount. At the present time there are in this same region 35,000 horse-power in use for aluminium; 25,000 horse-power for carbide of calcium; 15,000 horse-power for potassium or sodium chloride; and 22,000 horse-power for metallurgical purposes, such as the manufacture of steel. The town of Lyons receives current generated at Moutiers, at a distance of 180 kilometres (112 miles). The higher heads of water available were first utilised: Mr. Bergès started with the Chapareillan station, where the head is 600 metres (1,968 feet). In the same district the Epierre station utilises a head of 550 metres (1,805 feet). More recently the lower heads, averaging from 50 to 150 metres (165 feet to 490 feet), have been much sought after from watercourses in which the flow is comparatively heavy, mainly, perhaps, because the higher heads are combined with less regularity in the flow and with difficulty in arranging for regulating reservoirs.

"Among the individual stations, we may briefly mention that of Livet, on the Romanche, in the Isère, of a maximum capacity of 15,000 horse-power; those of Avignonnet and Champs, on the Drac, of 7,000 to 8,000 horse-power each. The Drac could alone generate 100,000 horse-power in the same department—that of Isère. In the above-mentioned stations the head is only from 18 to 37 metres (60 feet to 120 feet). In the Higher Savoy there is the Pont du Risse station, on the Giffre, where the head is about 71 metres (233 feet), with a capacity of 9,000 horse-power; and several others where the height of the fall is

considerable. In the centre of France—at Clermont-Ferrand—there is the Sioule station, of 6,000 horse-power, with a head of 25 metres (82 feet)only; in the same district a station on the Vézère supplies the town of Limoges. The *houille blanche* available in the Mediterranean region is rapidly being developed. The Jonage station, near Lyons, above referred to, belongs to the *houille verte* class, and the 16,000 horse-power it produces is now all utilised.

"Much hydraulic power, however, remains to be regulated in the vicinity and to the south of St. Etienne, and in all the districts between Lyons and the Pyrenees. The same may be said of the Higher Alps Department, where a total of 300,000 horse-power could be obtained in the dry season, and 500,000 horse-power with an average flow. The corresponding figures for Savoy would be 320,000 and 650,000 horse-power, and those for the Maritime Alps, north of Nice, 70,000 and 140,000 horse-power. Mr. Tavernier estimates that the whole district comprised between the Alps, the Rhône, and the Mediterranean could yield 3 million horse-power in the dry season, and 5 million horse-power with an average flow.

"It is estimated that in the south-eastern districts of France, and in the departments which adjoin the Pyrenees, there are available 1,300,000 horse-power in the dry season. In the Jura, Vosges, and in the centre of France there would be a further total of 900,000 horse-power; while for various other departments of the country the total is estimated at 1,400,000 horse-power.

"The total hydraulic power for the whole of France may therefore be estimated to reach from 9 to 10 million horse-power, available on the shaft of the turbines, or about the amount now produced by heat-engines. A large portion of this total has still to be turned to account by hydro-electric development."

A PROJECT FOR A TRANSALPINE WATERWAY.

AN ESTIMATE OF THE POSSIBILITY AND COST OF ESTABLISHING A CANAL OVER THE ALPS FROM VIENNA TO TRIEST.

Jos. Riedel—Oesterreichische Wochenschrift für den Oeffentlichen Baudienst.

A PROJECT which has long been the dream of the people of central Europe is the establishment of a waterway over the Alps to serve as a means of communication with the Mediterranean or the Adriatic. The project has received most attention in Austria, having been brought into prominence first about the close of the last century when the subject of canals was in the forefront of political discussion and there began an era of great activity in canal-building in France and Germany, to give the people of mid-Europe communication with the North Sea. Recently the project was considered by the International Navigation Congress and a special report has been presented to that body. The following details of the estimated cost are taken from an abstract of this report by Herr Jos. Riedel in a recent number of *Oesterreichische Wochenschrift für den Oeffentlichen Baudienst.*

In the examination of the economic feasibility of the scheme the question of the probable traffic is first taken up. It is pointed out that the establishment of a canal from Vienna to Triest, connecting the Danube and the Adriatic, is a problem essentially distinct economically from that of a waterway from Venice or Genoa west to the Lake of Geneva or north to the Lake of Constance and the Rhine. Vienna already has communication by water with the Mediterranean through the Danube and the Black Sea, and a canal from Vienna to Triest would have to compete with this route. On the other hand a waterway from Venice through the Po to the Lake of Geneva and thence to Basel and the Rhine would lead to Strassburg and Mannheim and consequently be much more favorably situated for the securing of traffic than the Vienna-Triest line.

It is estimated that the average freight-movement per head of population in the interior of Europe amounts to half a ton yearly. Of this fully one-half consists of raw material or package freight, for the distribution of which water transportation would be preferred to rail. By the open-

ing up of branches a good waterway through the Alps would soon have an influence over traffic for a distance of 60 kilometres on either side. It would eventually serve an area of 100,000 square kilometres and a population of 20,000,000, drawing therefrom a yearly traffic of 6,000,000 tons of package freight. An average haul of 300 kilometres and a profit of 2 centimes per ton-kilometre would result in a net annual profit of about 38,000,000 francs. On this basis, and taking into account the indirect social and political benefits such a waterway would confer, the economic feasibility of the project would be established beyond a doubt, even assuming an initial expenditure of 1,500,000,000 francs.

The technical difficulties in the way are not so easy of solution. The report enumerates as the problems connected with the technical possibility of the project the condition of the already navigable rivers and canals, the building of the open sections of the waterway, the establishment of numerous tunnel sections, the motive power to be adopted, the overcoming of the great differences of level, and the procuring of a sufficient supply of water at high altitudes. So far as the open sections of the canal are concerned, one of the great difficulties would be to secure a line free from curves of small radii. On this account it would be much more satisfactory to cut through an elevated table-land than to follow the windings of valleys, and from this point of view the line from Triest of Fiume over the Karst to the Danube would be preferable to one which would have to cross the Central Alps. In neither case, however, could a canal be built without resorting to considerable tunneling.

A considerable section of the report is given up to a consideration of the tunnels which would be necessary. On account of the probable size of the traffic turn-outs could not be used; these have proved unsatisfactory even in large open canals and a system of double tunnels would have to be resorted to. A boat 67 metres long, 8.2 metres wide, 1.8 metres draught, and of 600 tons capacity, such as is proposed for the Danube-Oder canal, would require a tunnel 12 metres wide and at least 80 square metres in section or for a double tunnel 160 square metres. The type of boat in use on French canals, 38.5 metres long, 5 metres wide, and 1.8 metres draught would require a section of about 70 square metres or for the double tunnel 140 square metres. It might be found more economical to use boats only 4 metres wide and of 200 tons capacity, such as are said to give good results on the Volga where the boats are usually towed in pairs.

Several examples of the cost of driving large size tunnels are given. A tunnel on the Marne-Saone canal, 4,820 metres long and 66 square metres in section, was driven through marl and chalk in six years and cost 2,500 francs per metre. A canal at Condes, 103 square metres in section and 307 metres long was driven in three years at a cost of 3,140 francs per metre. Judging from the cost of these and other tunnels, a tunnel through the Alpine strata of 60 square metres section would cost 3,107 francs per metre. It is estimated that on the line from Triest to Vienna there would be 22 tunnels of a total length of 9,320 metres. The total length of the line would be 512 kilometres and the total estimated cost 1,143,055 francs per kilometre.

THE DEVELOPMENT OF RADIO-TELEGRAPHY.

A REVIEW OF THE INVENTION AND DEVELOPMENT OF RADIO-TELEGRAPHY FROM A SCIENTIFIC STUDY TO AN APPLIED ART.

Report of the Select Committee on the Radio-Telegraphic Convention.

THE Select Committee, appointed by the British Government to consider the advisability of adhesion to the international Radio-Telegraphic Convention signed at Berlin in November, 1906, have completed their labors and submitted their report. A large part of the latter deals with matters more or less political, but apart from this the report contains a historical record of the development of wireless telegraphy, both scientific and political, which is unsurpassed by any previous publication. The following extracts taken from the section dealing with the

"invention and development of radio-telegraphy from a scientific discovery to an applied art" will be of general interest.

"Wireless telegraphy or radio-telegraphy means the transmission of signals by electrical energy between two points which are not connected by a wire or other metallic conductor. The term is specially used—and exclusively used in the convention—in connection with instruments employing the Hertzian waves, so called from their discoverer, Heinrich Hertz. Before the discovery of the Hertzian wave other methods were used experimentally for sending messages across space without conjunction other than the earth: (1) by earth induction, using two parallel or nearly parallel wires erected, for example, on either side of a stream, each end being fitted with telegraphic apparatus; (2) by electric magnetic induction; and (3) by a combination of the two former. This means was taken up by Sir (then Mr.) W. Preece in 1885 (then electrician to the Post Office), and a system was set up of telegraphic communication without direct connecting wires between places not more than six or seven miles apart. A wireless telephone service has been established by Mr. Gavey on this basis between Holyhead and the Skerries, and recently telephonic speech has been exchanged between the two stations with the greatest ease.

"The induction systems are not, however, suitable for communication over a long distance, nor for communication with ships, and the methods now used for that purpose are all based on the employment of the Hertzian waves. The means employed in transmitting messages across space without physical connection, consists broadly of two stations, a transmitting station and a receiving station. At each of these stations a wire or wires must be erected in the air by means of a mast, tower, balloon, kite, etc. This structure of wires is known as the antenna or aerial. Speaking generally, the greater the range intended to be covered the higher or more extensive must be the antenna or aerial. The energy is generated by a battery or generator worked by a steam, gas, oil, or other power engine, and is communicated to the aerial by the transmitting apparatus proper.

"The receiving apparatus is also connected with the aerial. There are many forms of receiving apparatus in use, and it may be said that one of the principal differences between the several systems of wireless telegraphy consists in the various forms of receiving apparatus. In some the apparatus automatically records the dots and dashes of the Morse alphabet, but in most forms a telephone is attached, and the operator hears the dots and dashes, and this permits of more rapid working than any recording instrument yet devised.

"With the most powerful stations very great distances have been covered, and signals have actually been transmitted across the Atlantic, but in the present condition of radio-telegraphy communication has not been effectively maintained with regularity over so great a distance, especially by day. The maximum effective range for regular communication by day or night may be put, possibly, at 1,000 or 1,500 miles, but this state of affairs is changing almost month by month. Wireless messages are frequently sent from Poldhu to Gibraltar and Malta. As regards the ordinary ship and shore stations, the effective range may be said to vary between 50 and 300 miles, possibly rather more, according to the power of the station.

"The signals are usually sent out with equal energy in all directions. A message sent out, for instance, from the high-power station at Poldhu, Cornwall, and intended for ships in mid-Atlantic, has been equally received at Nauen, near Berlin, and at the Dutch station at Scheveningen, or at Gibraltar. Attempts have been made to devise methods of directing the waves, or, at least, of sending them with the greatest energy in one particular direction, but so far only with moderate success. The Admiralty are unable to determine the direction in which a wireless message is coming under certain conditions.

"The main defect which was first found in the working of wireless telegraphy, resulted in part from this inability to control direction. As every receiving station within range of a transmitting centre could read all the messages sent from that centre, it was not possible for more than two stations in a given area to interchange signals at a given time without mutual inter-

ference. It was impossible, of course, for the ether within a wide radius thus to be monopolised by two persons if the invention was to be of real practical value. It was also obvious that if two sets of apparatus could be so accurately adjusted the one to the other as to ensure reciprocal radiation, whilst other apparatus not so adjusted would not be affected, the practical problem would be solved. It is in the direction of 'syntony' or the 'tuning' of apparatus so as to induce 'selectivity' between them that recent scientific research and experiment have been chiefly concentrated; and, as will appear later, the more or less complete manner in which this has been achieved between different systems constitutes one of the difficulties placed before the committee.

"The committee do not wish to express any opinion on controversial questions of priority and patent right, but it appears to be generally admitted that the Hertzian waves were first experimentally applied for practical telegraphic purposes in 1895-96 by Mr. Marconi. Many inventions and improvements by Mr. Marconi and others have appeared since at a rapid pace, and there are now several 'systems' or 'methods' in existence, whilst the number of patents is very great.

"The principal systems in use are: Marconi—The first practical system in the field. The first Marconi British patent was applied for on June 2, 1896, and accepted on July 2, 1897. De Forest—American in origin; acquired in Great Britain, and it is said for all parts of the world except North America, by a British company (the Amalgamated Radio-Telegraph Company). Fessenden—American. Lodge-Muirhead—British, both as regards invention and ownership; first patent applied for May 10, 1897, accepted Aug. 10, 1898. Telefunken ('far-sparking')—German, an amalgamation of the systems of several different inventors (Slaby, Arco, Braun, Siemens). Rochfort—French. Branly-Popp—French. Poulsen—Danish, of recent invention, the rights in which for all parts of the world have also been acquired by the Amalgamated Radio-Telegraph Company. Shoemaker—American. Massie—American.

"The use of radio-telegraphy is rapidly increasing. A large number of instruments are already in operation in various parts of the world. Conflicting evidence was given as to the exact number in commercial use, but this is partly explicable by the fact that conditions are rapidly changing, and that there are in existence a number of experimental stations and other stations not open for commercial work. A relatively small proportion of the existing stations are on British territory. The greatest number are in the United States. There are also a considerable number in Italy and Germany, a few in Holland, Belgium, Spain, and France, and several for non-commercial purposes in Russia. According to the most recent returns, it would appear that there are 186 commercial stations throughout the world, of which some 63 are Marconi and 123 are other than Marconi. There is a preponderating number of Marconi stations in Great Britain, Italy, and Canada, but in all other parts of the world, with few exceptions, the stations are on other systems. The most important stations are those situated on the south coast of the United Kingdom, which is, owing to its geographical situation and the predominant part it plays in the maritime business of the world, the chief focus of ocean commerce."

ELECTRIC LOCOMOTIVES FOR MOUNTAIN GRADES.

A DISCUSSION OF THE ADVANTAGES OF ELECTRIC TRACTION OVER STEAM ON THE MOUNTAIN DIVISIONS OF RAILWAYS.

Engineering Record.

THAT the advantages of the electric over the steam locomotive for service on heavy grades, which have been so conclusively demonstrated on Italian railways, are being recognized by American engineers is evidenced by the fact that the Great Northern Railway has adopted electric traction for its Cascade Tunnel section and that larger projects are under serious consideration by other roads. The difficulties of steam traction on the mountain sections of American railroads

have long been accepted as irremediable since not even the Mallet type of locomotive with its large draw-bar pull and great horse-power capacity succeeded in lowering materially the high operating costs on heavy grades or in removing the dangers, delays and limitations of railway operation in mountain sections. A recent editorial in *The Engineering Record,* however, looks for a rapid and immediate development of electric traction on mountain grades on account of the general recognition of the advantages outlined in the following extracts.

"Electric operation on mountain grades appears to offer many advantages of greater importance than a generally admitted small saving in the expense of fuel, though this in itself may prove a most attractive feature under certain conditions and in certain localities. Admitting that electric power produced in hydro-electric stations costs less per ton-mile hauled than coal inefficiently burned under the abnormal overload conditions obtaining in steam locomotive operation on mountain grades, this item in itself will seldom show a sufficient return on the capital required for electrification to make it attractive to the steam railroad management.

"It is a well known fact that the figures given in annual reports for locomotive maintenance running from six to ten cents per locomotive-mile do not apply to those locomotives operating under heavy grade conditions, and a maintenance charge ranging from ten to eighteen cents per locomotive-mile is not uncommon in this class of work. It is contended that the electric locomotive can perform the same service with a much less maintenance charge than is required in steam locomotive operation; while the 50,000-mile endurance run of the New York Central locomotive extended but a year, it showed a maintenance charge of less than one and one-half cents per locomotive-mile, and it is probable, according to electrical specialists, that an electric locomotive properly proportioned for service can be maintained for much less than a steam locomotive, performing the same service. Just what the gain will be in this direction is not apparent from operating figures, and it will be interesting to see results from the New York Central electric zone after electric locomotives have been in service operation for a year or more. The saving in the maintenance charge of locomotives is reflected more generally than merely in labor and material for necessary repairs, as a low maintenance account means great reliability, and freedom from breakdowns and delays, so that if all expenses due to failure of locomotives in service were charged directly to maintenance of locomotives this item would assume formidable proportions. Hence, a saving in this item is of far-reaching importance and should prove a valuable asset to the electric locomotive on heavy-grade work, where the conditions of operation are very exacting as regards performance of the motive power.

"The great advantages offered by the introduction of the electric locomotive seem to lie more in the direction of increasing the tonnage capacity of the single track, commonly met with on heavy grade divisions, and the general reduction in cost per ton-mile resulting from the handling of heavier trains at higher speeds with a certainty of operation not shared to an equal extent by the steam locomotive. Where the capacity of the electric motor is properly proportioned to the work which it has to do, there is no doubt of its being a highly efficient and extremely reliable piece of apparatus, requiring little or no attention, only periodic inspection, and with complete independence of the round houses, coaling towers, water tanks, and ash pits, required for the frequent repairs and grooming of the steam locomotive. This freedom of action and reliability must be reflected in a greatly increased daily mileage, a lower crew expense, and a considerable curtailment of the false mileage common to steam locomotive operation.

"The electric locomotive is merely a transforming or converting piece of apparatus and can draw an unlimited supply from its distant stationary power house; hence its output is limited only by mechanical considerations, and the result is a type of locomotive capable of delivering an enormous power if designed to do so. Its motive power can be sub-divided into several motor units without loss in efficiency or increase in dead weight, thus permitting a construction which can utilize the entire

weight of the locomotive upon the drivers and still keep within the recognized limits of weight upon each driving axle. Not only can the motive power in one locomotive structure be divided to suit the convenience of construction, but two or more locomotives can be coupled together and operated by a single motorman in the cab of the leading locomotive. While the steam locomotive, and especially the larger types as represented by the Mallet compound, is seriously handicapped by the difficulty and expense of stoking, the electric locomotive can be operated in groups of two or more by a single operator who has under his complete control the 2,000 or 3,000 horse power concentrated in each of the several locomotives of the group. The possibilities opened up in this direction are enormous.

"A steam locomotive is considered large when its boiler is capable of sustaining an output of from 1,500 to 2,000 indicated horse power. The electric locomotive, on the other hand, as represented by the 3,400 type now operating on the New York Central, can give a sustained output of 2,200 horse power rated with ample margin of overload in excess of this. It should be well understood also, that this 2,200 horse power output of the motors is obtained with a total weight of something less than 100 tons, of which 68 tons is upon the drivers, and this locomotive was designed for a specified duty and does not in any way represent the maximum possibilities of electric locomotive construction.

"It seems entirely practicable to construct an electric locomotive or a group of electric locomotives capable of delivering any drawbar pull permitted by the strength of the drawheads, and, moreover, this drawbar pull can be delivered at any speed desired, in this respect far exceeding the possibilities of steam locomotive construction. This means that instead of operating trains downgrade at a maximum speed of from 25 to 30 miles an hour and up grade at a maximum speed of from 6 to 12 miles per hour, it is possible with electric locomotives to operate at any speed up grade that is consistent with the alignment of the track. In other words, the same schedule speed can be maintained up grade and down grade, thus greatly facilitating the movement of trains on heavy grade sections and vastly increasing the tonnage of the tracks.

"Air brake equipments on all cars have contributed towards increasing the size of trains and safety in operation on mountain grade sections, but such operation is still handicapped by the limitations and dangers attending the holding of a heavy train on a downgrade of long extent. As the electric locomotive is a convertible piece of apparatus, changing electricity into mechanical power and vice versa with equal efficiency, it offers a means of relieving the air brake entirely or in part, and performing the functions of braking by returning electricity to the line. Elimination of air-brake shoe troubles and overheated tires, will be appreciated by steam railroad operators as soon as this valuable feature of the electric locomotive becomes well understood, and aside from the economic value of electric braking, it offers much towards the safety of carrying passenger trains over mountain grade sections."

THE PROGRESS OF THE SUBMARINE BOAT.

A REVIEW OF THE RESULTS OF THE TESTS RECENTLY CARRIED OUT BY THE UNITED STATES NAVY DEPARTMENT.

Engineering.

THE recent announcement that an order had been placed by the United States Navy Department for seven submarine boats of the "Octopus" type recalls the elaborate and searching tests made in the early summer of the present year to determine the best available type of submarine boat for the proposed extension of this arm of the Navy. Three designs were submitted to the Board: the "Octopus" of the well-known Holland type, a boat of 273 tons displacement, launched in 1906 by the Electric Boat Company of New York and embodying the latest conceptions of this design of boat, the "Lake," and a small model of the sub-surface type. The report

submitted to the Navy Department shows the unanimous opinion of the Board to have been in favor of the adoption of the "Octopus" type. The results of the tests as given in the report are summarized in an editorial review in a recent number of *Engineering*, which also contains some interesting details of the progress of the submarine boat in other navies.

"The Octopus, like the great majority of submarine craft, is driven on the surface by internal-combustion engines, and the consumption is such as to insure that, with a fuel storage supply of 4,000 gallons, the radius of action will be 700 miles. Electric motors are used for propulsion when submerged. The surprisingly good speed of 10.03 knots was realised as a mean of three measured-mile runs with the conning tower of the vessel 10 feet under the surface. This is a splendid performance. On the surface the maximum speed was 11.57 knots, and the mean 11.02 knots. As regards diving, the vessel went down at an angle of 8 degrees to a depth of 26 feet within 40 seconds; she immediately returned to the surface, remained there under observation for five seconds, and dived once more. The complete evolution was carried out in about a minute and a half. This facility of disappearance is of the greatest importance from the point of view of fighting efficiency, and the result is, therefore, most interesting. Again, the time taken to disconnect the gasoline engines and to couple the electric motors was only 12 seconds, five seconds for the former, and seven seconds for the latter operation. As to manœuvring, the vessel, when awash, made a complete circle in 3 minutes 40 seconds, the diameter of the circle being about 200 yards. Running on the surface, with only one screw, she made a half circle to starboard in 1 minute 35 seconds, and a half circle to port in 2 minutes 40 seconds; in the latter instance the screw propeller was working against the rudder. Going full speed ahead when awash, the vessel was able to reverse her direction of propulsion in 52 seconds. As to endurance, the boat was required to remain 24 hours submerged at a depth of 200 feet, and it was computed that only 1-45th of the total air supply was exhausted, which suggests a long radius of action under water.

"The Lake boat also did well in remaining under water for this lengthy period, but in the other tests the Octopus proved superior. The Holland boats are fitted with an automatic device for blowing out the tanks when submerged, in order that the vessel may rise to the surface from any predetermined depth, for which the apparatus is set to come into action. The mechanism was set to be effective at 40 feet, and when this depth was reached 30 tons of water were blown out of the ship in 18 seconds, the total time taken for the test, including the immersion of the boat, being 48 seconds. Another important trial was made in connection with submarine bell signals from the 'mother' ship, and by this means it was possible for the commander of the fleet to communicate to the various vessels when submerged. It was also found that wireless telegraphy could be used on the Octopus when on the surface and awash. The masts were 30 feet high, and the antennæ, 50 feet long, consisted of four strands of wire. Under these conditions it is anticipated that the range of communication will be 40 miles.

"These facts, which were evolved by the Government tests, again prove the practicability of submarine navigation, which has frequently been demonstrated, although actual data have been withheld. The data further establish the efficiency of the Holland type of submarine boat, and 'that she is equal to the best boat now owned by the United States or under contract.' The results suggest that a larger boat than the vessel referred to, which is of 273 tons displacement, would be a superior weapon. As to the Lake type of boat, the Commission report:—'1. That the type of submarine boat as represented by the Lake is, in the opinion of the Board, inferior to the type as represented by the Octopus. 2. The closed superstructure of the Lake, with the large flat deck which is fitted to carry water ballast, and to contain fuel tanks and air flasks, which is an essential feature of the Lake boat presented to us for trial, is inferior to the arrangement on board the Octopus for the same purposes, and also, in the opinion of the Board, is detrimental to the proper control of the boat. 3. The hydroplanes, also an essential feature of the Lake boat presented to us for trial,

were incapable of submerging the boat on an even keel. They are, therefore, regarded as an objectionable incumbrance.'

"As regards the design known as the sub-surface type of boat, the Commission very properly reported that it could not be compared with submarine boats, being of an entirely different type. In this class of boat the machinery, magazines and habitable quarters are enclosed in a submerged hull, from which there is communication to a surface hull through conning-towers or armoured-tubes, the two hulls being joined, pretty much like the booms of a girder, by web plating or cellular structure. The surface hull is used only for the accommodation of the guns and the gear for controlling propulsion and navigation. In other words what would be considered the upper deck of an ordinary ship is separated from the sub-structure with the exception of tubes for communication, so that in action damage to the upper part would not affect or endanger the lower hull with the machinery and magazines. The system is ingenious, but is, as the Navy Board point out, analogous to the torpedo-boat or torpedo-boat destroyer. The sub-surface boat does not afford that advantage of invisibility which is the great desideratum met by submarine craft, and therefore its potentiality for damage is not so great. There was only submitted to the Board a quarter-size model, and consequently it was impossible to make a satisfactory comparison, even with the performance of torpedo-boats and torpedo-boat destroyers. The Commission, however, point out that so far as their observation went there was no reason to doubt that the guarantee made as to speed, etc., would not be carried out. The sub-surface boat is less vulnerable than the torpedo-boat, requires fewer men, and has a larger steaming radius, but she has less speed and greater draught. The President of the Commission, Captain Adolph Marix, took exception to the general pronouncement that the tests of the sub-surface model 'did not develop that boats of this type, built of a size suitable to render their qualities available, are equal to the best torpedo-boats now owned by the Government.' In the opinion of the Captain, the smallest size of sub-surface boat fitted with a regular torpedo-tube, and built to give a speed of 15 knots, would be a weapon of great value, additional to any now owned by the Government, and that this value could be enhanced by the rapidity with which they could be constructed, and the ease with which they could be transported.

"The Board were not called upon to pronounce as to the strategical or tactical advantages of the submarine boat. This was scarcely necessary in view of the general consensus of opinion in all Admiralties in favor of the type, and the large number now being built by the various Powers. In the recent Dilke return it was shown that there are already in existence 117 vessels of a submarine type, and that there are building 86; while the programmes of many Powers, in addition to the United States, anticipate very considerable additions. We, in Britain, have 37 completed and 11 on order, and the size has steadily advanced from 122 tons displacement to 400 tons, the power of the machinery having increased in the same period from 160 to 800 horse-power on the surface, while the power of electric motors for propulsion under the surface has increased from 70 brake horse-power to well over 200 brake horse-power. These vessels, as we have already indicated, have been evolved from the Holland type, and long experimental research has been carried out, with the result that no dubiety exists as to the efficiency of the type, while at the same time there is achieved that homogenity which is so important in the training of the *personnel* to secure a sufficient supply of men during action, and to maintain the highest efficiency, which is dependent on thorough experience in these vessels more than in any other. France has forty boats completed, and fifty-nine are in course of construction. Here there is great diversity of opinion as to the best type of vessel, and the boats vary in size from 21 to 560 tons displacement. The tendency, however, is all in favour of vessels of large size, most of the boats under construction being of about 400 tons displacement. Russia has twenty vessels completed, and has on order eight. Germany has moved more slowly in this matter, but she has completed her first vessel and has two building; the estimates for the next three years provide about

£350,000 for submarine construction. Italy has four vessels building, and two in course of construction. Japan has seven built, while the United States have in commission eight vessels, and four in course of completion, all of the Holland type." As noted above, seven additional boats of this type have been ordered for the United States Navy since this review of the trials was written.

THE RELIABILITY OF MOTOR CARS.

A DISCUSSION OF THE TROUBLES DEVELOPED IN THE MOTOR CARS COMPETING IN THE RECENT RELIABILITY TRIALS OF THE SCOTTISH AUTOMOBILE CLUB.

Engineering..

A FACTOR which has been largely instrumental in the rapid development of the technology of automobile construction is the attention which has been paid to the gathering of accurate data on the performance of cars during the numerous international competitions held by several of the larger automobile clubs. Of these contests, those held annually by the Scottish Automobile Club have probably been of more value to the motor-car industry than any others, in that they are not purely speed competitions but are designed to test all the qualities which are essential to the perfect touring car. The trials extend over five days, and are held over a course of 750 miles of highland and mountain road. The worst of the many bad hills encountered are utilised for special tests of starting, stopping and climbing power. Since every detail of the behavior of every car is carefully noted by official observers, it is obvious that the conclusions which may be drawn from the final report are of the utmost importance as indicating the details of automobile construction which still require attention from an engineering point of view.

In the Scottish reliability trials of the present year there were 96 starters. Of these, Great Britain contributed 57, France 24, the United States seven, Italy two, Germany, Belgium, Austria and Holland one each, and there were in addition two hybrid cars, partly French and partly English. The following discussion of the troubles which developed in the competing cars during the trials is taken from a review in *Engineering* of the recently published official report.

"It is beneficial to study the performances of the cars from an engineering point of view. The most valuable lessons are to be learnt from the various troubles that were experienced on the road, all of which are noted faithfully and impartially in the official report. We will first take the steam-cars, of which there were but two, both of a well-known American make. Many engineers have a preference, or at least a sentimental liking, for the steam-car, and its silence is certainly attractive to other purchasers; but we fear steam vehicles will have to justify their existence more conclusively than on the trials in question before they ever become serious rivals to the petrol type. It may not be fair to judge their merits on the performances of two only, but on official trials every car must stand or fall by its official performance. The first of the steamers, rated at 20 horse-power, withdrew on the third day, having gone through a sea of troubles, mostly connected with burner, valves, or steam-pipes. It had to fill up with water five times, procure more petrol, and—curiously for a steamer—it failed once on a hill. The second steamer, rated at 30 horse-power, completed the trials, but lost more marks than any one of the petrol-cars, excepting two. In this case it seems to have been the vaporiser and feed-pump which gave most trouble, although on one day there were apparently five engine stops pure and simple. To make matters fair for steam-cars competing, every vehicle was allowed two minutes in which to restart after a stop. On the morning starts, after the first day, marks were deducted for more than this delay in starting, and the steamers were always penalised, their average starting time being over six minutes.

"Turning to the performances of the petrol-cars, we find thirteen of these, or about 14 per cent., had to withdraw from the contest. This may seem at first a large pro-

portion of the total, but the uselessness of proceeding with anything of the nature of a contest when hopelessly out of the running, and the exceedingly severe nature of the trial, must be taken into account. The conditions were far more arduous than a private tourist need encounter, and in spite of the fact that nearly 20 per cent. of the starters made non-stop runs, one must not be too hard upon those which did not. Every one of the ten small cars in Class I., costing, for chassis and tyres complete, not more than 200*l*., finished the course, which is highly creditable. Of the vehicles, which were withdrawn, three cars gave up owing to stripped gear, and another to vague 'gear troubles.' Kindred causes, accounting for two more withdrawals, were broken ball-race and differential and broken driving-pinion. A seized gear-shaft and a broken brake-drum shaft put another two out of action. Of the remainder, one got broken spokes and a bent axle when taking a sharp turn, one withdrew on account of a broken spring, one owing to a broken gear-striking fork, one because the clutch-leather burned out, and the last because 'pins dropped out of a driving-shaft.' It will be seen that gear trouble of one sort or another caused the bulk of the serious mishaps in the contest; and makers might well take this lesson to heart, for driving skill of the highest order was presumably employed; and if gears are stripped by good drivers, what can be expected when novices are at the wheel? The burnt-out clutch does not necessarily prove anything, except that the clutch slipped; and although, of course, a slipping clutch is one of the minor points which may cause so much annoyance to car-drivers, and should be more unusual than it is, one is bound to sympathise with the makers on this occasion. The failure of the wheel and axle at a bend in the road is vastly more serious than any of the other troubles which led to withdrawal, and, again presuming reasonably good driving, is inexcusable. The car to which this accident happened was of Continental manufacture.

"A careful analysis of the minor troubles which were met with, with a view to their elimination, should be made by every firm engaged in the manufacture of cars. There are in the official report notes of every 'regrettable incident,' no matter how trivial, which occurred in running something like 67,000 car-miles. Most information would be gained by comparing the frequency and gravity of any particular trouble with the type of mechanism involved; but to do this requires more details of the cars than are given in the report. However, in the majority of cases it should not be beyond the power of any manufacturer reasonably well acquainted with the work of his competitors. Neglecting the steam-cars, the tribulations of which have already been referred to, we find broadly three great fields in which attention to details seems urgently wanted if the lesser troubles of the motorist are to be eliminated. The carburettor and petrol supply together are responsible for the bulk of the involuntary road-stops; ignition troubles of all sorts run a fairly close second; and the water-circulation system comes third. These three sources of annoyance overshadow all others. The petrol-engine, as a piece of mechanism, seems almost to have reached perfection; for although the engine-stops are fairly numerous, they are mostly due apparently to changing gear on hills, and mechanical defects in this important part of a car seem to have been practically non-existent.

"Defects of, or troubles in connection with, the carburettor and petrol supply were responsible for something like fifty road-stops, wasting an aggregate of seven hours, although more than half of the failures took less than five minutes apiece to rectify. Nearly twenty were due solely to choked carburettors or petrol-pipes. This surely is a state of affairs that is capable of remedy. A useful comparison might be made of the chokes occurring with pressure-fed as against gravity-fed carburettors, and the relative freedom of multiple-jet as against single-jet devices. Probably the most prolific source of chokes is dust, either originally in the petrol or finding admission when the tank is refilled. Until carburettors and pipes are designed so that they will not choke, the motorist can do little more than exercise care in the exclusion of dust; but as we must presume this to have been done on the trials, the number of chokes demands the attention of manufacturers.

"Ignition troubles caused about thirty

road-stops, aggregating about five hours; though here, again, the length of the average stop only amounted to a few minutes. In eleven cases the sparking plugs alone were apparently to blame. The reliability of these simple little articles is yet far from perfect, although the price charged by good makers is more than enough to cover the best of workmanship and material. Sparking-plugs are much better than they formerly were, especially as regards sooting-up, but mechanically they are often very bad. The temperature at which they work, and the voltage they have to stand, both are adverse to reliability; but as a comparatively cheap plug will show often an almost indefinite life, the conditions are not insurmountable.

"Troubles with the cooling-water system, leakages, etc., caused more than a dozen stops, aggregating nearly four hours, without counting the numerous cases where extra water had to be obtained for no apparent cause. Leaks seem to have been a prolific source of trouble, and the rigidity of radiator fastenings, pipe connections, etc., no doubt accounts for the occurrence of many leakages. The radiator in every car ought to be cushioned from the frame in such a way that it is protected, as far as possible, from vibrations and shocks, and the pipes from it ought also to be flexibly attached. From the report it is impossible to gather which type of radiator or circulating system it was that occasioned most trouble.

"It is impossible to say from the particulars given of the equipment of the contesting cars which is the most popular form of ignition. Most of the cars were fitted with two alternative forms: the ordinary battery and coil, and some type of magneto. The cheaper vehicles had accumulator and coil only, and many others had only either high-tension magneto, or low-tension magneto. When alternative ignitions were provided, the high-tension magneto seemed the most popular, but the records are frequently indefinite as to the type used. One might deduce conclusions by comparing the frequency of ignition troubles with the type of ignition employed, but whether they would be accepted by the interested parties is another matter.

"The tyre troubles we will not enter into, as so much of pure chance is involved in the question. It is sufficient to say that, on the whole, the tyres behaved as well in their way as the cars, and no car was penalised for tyre delays, as in no case did any competitor lose more than an hour on this account during the whole of the trial."

THE PRESENT POSITION OF THE LARGE GAS ENGINE.

A DISCUSSION OF THE CONSTRUCTIVE DIFFICULTIES WHICH HAVE PREVENTED ITS RAPID ADVANCE IN ENGLAND.

Dugald Clerk—British Association for the Advancement of Science.

WHILE the gas-engine industry in Great Britain is in a condition of sound commercial prosperity, the production is limited, for the most part, to motors of small powers. With regard to the large gas engine, British engineers have assumed a conservative attitude, and while considerable experience has been accumulated and British practice in large gas-engine construction has developed steadily, there still remains a number of constructive difficulties which must be overcome before the gas engine of high power can compete with the reciprocating steam engine. The following abstract outlines these difficulties as described by Mr. Dugald Clerk in a paper read before the recent meeting of the British Association for the Advancement of Science.

"Engines of small and moderate powers are built in large quantities; their difficulties have been thoroughly overcome and they have attained to an almost fixed type. The larger part of the British gas-engine industry is occupied with such motors, generally under 100 horse power per cylinder. The turnover in Britain at present of such engines is at the rate of some 300 engines per week. It is generally recognized that these engines are as reliable as the best steam-engines of similar dimensions and much more economical in fuel consumption. The smaller engines mostly use coal gas, and the larger producer gas evolved by

means of modern suction producers using anthracite for fuel.

"Experience in the construction and design of the large gas-engine is accumulating. They are better understood in Britain than they were even three years ago. It is a remarkable fact, however, that engines which attained a reputation for success upon the Continent were not at first successful here. This is shown by the fact that the Koerting, Oechelhauser, and Cockerill engines had all to be modified in their construction by the British engineers who undertook their manufacture here. This is also true of the Diesel oil-engine. Alterations have been made in England to fit it for the conditions of practice here. All these engines have been much improved in the last few years, and they are now, no doubt, better able to compete with the steam-engine with regard to reliability and freedom from breakdown.

"Large gas-engines of English design have also been built in greater numbers, principally by the Premier Company, Messrs. Crossley Bros., Limited, and the National Gas-Engine Company. English designers have always felt the desirability of keeping down cylinder dimensions as much as possible, and in this Continental designers have recently shown a strong tendency to follow them. This trend is due to a more general recognition of two facts: practical difficulties with large-diameter cylinders due to unequal expansions, resulting in cracking, and a better appreciation of the fact that increase in cylinder and other dimensions requires an increased expenditure in metal and workmanship in greater proportion than increase of power obtained. The large gas-engine really presents two distinct problems. The first is to build engines of large power which will continue to run effectively and economically for long periods without breaking down, and the second is to build such engines at costs sufficiently moderate to enable the engines to effectively compete with the large steam-engines in the matter of first cost. British engineers recognised for some time that the first part of the problem has been solved to some extent on the Continent, but many of them have felt that this solution has involved weights of material and costs of construction which are almost prohibitive, considering the moderate powers obtained. In fact, English engineers consider the large gas-engine as it at present exists both too heavy and too costly for its power. Personally, I do not believe that sound and continued commercial success can be looked for with really large gas-engines until some better solution be found for their present constructive difficulties. Apart from the questions of the engines themselves there are other difficulties which prevent the equal competition of gas-engines with steam-engines for powers, say, greater than 400 horse power or 500 horse power. Coal gas is too expensive a fuel for large engines. Producer gas, evolved by the suction producer from anthracite, air, and steam, effectively meets the wants of medium-sized engines up to 200 horse power, but the cost of anthracite handicaps engines of larger size, and equal competition will not be possible until better bituminous fuel producers are designed than those which at present exist. The work on the Continent has not aided the solution of the bituminous fuel producer problem. Practically all the large Continental gas-engines are operated with blast-furnace gas. Some success has been attained in Britain as the result of strenuous and praiseworthy efforts by Dr. Mond, Messrs. Crossley, and others, but it cannot yet be said that an entirely satisfactory bituminous producer has appeared. In my view no bituminous fuel producer can be considered really satisfactory until it attains simplicity, lightness, and the fewness of parts of the anthracite suction producer which now forms so large a British industry. Returning, however, to the engine difficulties, the large gas-engine may be considered as combining the difficulties of hydraulic engineering work at considerable pressures with those proper to a boiler furnace or flue. The possible pressures to be resisted by such engines cannot be taken as less than 400 pounds to 500 pounds per square inch, and a heat flow through the cylinder and combustion chamber walls has to be provided for greater than that of most boiler furnaces. It is obvious that here we have contradictory conditions involved, which become rapidly onerous with increase of dimensions. Thick castings are required to stand the high pressures, but to allow free heat flow from

the flame within the cylinder to the water in the water-jacket calls for thin castings. Engines of small dimensions do not involve any serious conflict, but where metal is required of about 3 inches thickness to resist internal pressures the temperature difference between the flame and water side of the metal becomes serious, and great stresses are set up which ultimately lead to the cracking of the castings. Great attention has been paid to this phenomenon of cracking, and in existing large gas-engines the difficulty has been partly met by skilful design and special quality of metal used. Although much ingenuity and skill has been spent in this direction, yet it is found that a dimension limit is very soon reached. Cylinders, for example, of 51 inches diameter have been found to be too large. Nothing but the highest skill in designing and the greatest care in the choice of material and workmanship enables such cylinders to withstand for any length of time the severe treatment to which they are exposed."

A NEW METHOD OF CUTTING METALS.

A DESCRIPTION OF A SYSTEM FOR CUTTING HEATED METALS BY MEANS OF A JET OF OXYGEN, RECENTLY DEVELOPED IN FRANCE.

Léon Guillet—Le Génie Civil.

ON account of its portability and convenience of handling, oxygen has recommended itself for several industrial applications connected with the metal trades. Welding is cheaply and easily performed by means of the oxy-hydrogen or the oxy-acetylene blowpipe, and in many other processes the use of oxygen has come to be a recognized practice, particularly in cases where an easily transported apparatus is of advantage. One of the most important of these applications is in the cutting of metals, for which oxygen is successfully used in several works in France. The following interesting description of the process is taken from a paper by Dr. L. Guillet in a recent number of *Le Génie Civil.*

The system as at present developed is comparatively recent. Since 1901 a jet of oxygen has been employed at the Say Refineries, not for actual cutting but for breaking down old pipes and I-beams. The metal was first heated to the temperature of fusion by means of a blowpipe and then, discontinuing the application of the heating gas, a stream of pure oxygen was later applied to the heated metal. The operation was in two parts, first heating of the metal and later burning it away. It was possible in this way to break up the metal into different parts, but the operation produced a very large and heavy cut with many blisters and it was found impossible to secure a clean separation by this method. It has been successfully applied, however, to breaking down metallic concretions in blast furnaces.

The method as at present developed is a great improvement on the old. The apparatus consists of two blowpipes which operate simultaneously; the first, an ordinary oxy-hydrogen or oxy-acetylene blowpipe, heats the metal to the desired temperature; the other, attached to the first and following it at a distance of a few millimetres, projects upon the heated metal a jet of oxygen under pressure. By this means the metal which is heated by the first blowpipe, burns under the influence of the oxygen; there is formed an oxide more fusible than the metal itself, which is driven forward by the strength of the oxygen jet. The resulting cut is extremely clean, with no appearance of blistering.

In view of the numerous applications which may be made of the method a number of different devices have been developed for various kinds of work. Cutting along a straight line, as for steel sheets, armor plate, etc., is accomplished by the use of a traveling carriage, carrying the blowpipe, which is driven by an endless screw. In this apparatus also the blowpipe is mounted on a swinging arm which permits it to trace out arcs of circles. Several of these devices are used for cutting armor plate at the French arsenals and navy yards.

A rolling device, consisting of a blowpipe mounted on a crosshead carrying an adjustable roller at each end, may be used

for making either straight or beveled cuts. This apparatus is also provided with a swinging arm for the cutting of circles or spirals. The device is largely used by the Chemin de fer du Nord for cutting T-rails.

For cutting pipes, the blowpipe is mounted on an annular ring which is clamped to the pipe and about which the blowpipe revolves. By means of this device pipes up to 300 millimetres in diameter may be cut in place. A universal portable apparatus is so arranged as to admit of cutting out any desired section, the blowpipe being guided by cams of special shapes. Other devices may be applied to cutting circular openings of 30 to 350 millimetres diameter in plates of any thickness, to cutting shafts up to 130 millimetres diameter, and lastly for cutting openings of any radius in steel pipes for the purpose of making elbows, the bevel being cut in the end of the other pipe by the same machine. For the preparation of two pipes of 150 millimetres diameter in this way the time taken was four to five minutes, a great improvement on the 30 to 40 minutes required by other methods.

M. Guillet gives some interesting examples of the rapidity of this method of cutting metals, in which lies its chief value. An armor plate, 160 millimetres thick, was cut through for a length of one metre in ten minutes. A similar length in a plate 20 to 30 millimetres thick can be cut in less than five minutes at a cost of not more than one and one-half francs. To cut a man-hole 300 by 400 millimetres in a plate 20 to 30 millimetres thick takes from four to five minutes. A pipe fitting, 150 by 150 millimetres, in a pipe 5 millimetres thick takes three to four minutes and costs 12 to 15 centimes, while the same operation could not be performed by hand in less than 35 to 40 minutes.

In one case a steel stairway was cut through in a quarter of an hour. A workman cut through 130 T-irons, 200 millimetres high, imbedded in cement, in three hours. The system has been largely used in the French navy yards for the breaking up of ships and has been found very satisfactory in many applications. It is particularly useful in deriveting plates: the head of a rivet can be burned off in less than twelve seconds without injuring the plate itself.

The maximum thickness which has been cut by this method up to the present is 210 millimetres in armor plates, but a thickness of 300 millimetres has been attained in round shafts. M. Guillet has made a number of tests to determine whether the cutting by this method has any effect on the physical properties of the metals. Under the microscope the steel appeared quite unchanged and other tests by shock, etc., showed its strength to be absolutely unimpaired. On this account and considering the cheapness and rapidity of the process, he looks for a wide and growing use of the system in the near future.

A CO-OPERATIVE SYSTEM OF TECHNICAL EDUCATION.

DETAILS OF A CO-OPERATIVE COURSE OF ENGINEERING INSTRUCTION AT THE UNIVERSITY OF CINCINNATI.

Herman Schneider—Society for the Promotion of Engineering Education.

THE following extracts from a paper read before the annual meeting of the Society for the Promotion of Engineering Education describe an interesting experiment in technical education which is just entering upon its second year at the University of Cincinnati. Some six years ago the writer, Mr. Herman Schneider, began an investigation to discover, if possible, what requirements the graduates of an engineering school should fulfil and the best means of training students to obtain the desired results. The co-operative course described below is the result of his researches. The outcome of the experiment, which seems to offer a solution of many of the difficulties of both students and the employers of graduate engineers, will be watched with great interest alike by the governing bodies of engineering schools and by industrial managers.

"This course is so planned that the students taking it work alternate weeks in the engineering college of the university and at the manufacturing shops of the city. Each class is divided into two sections al-

ternating with each other, so that when one class is at the university the other is at the shops. In this way the shops are always full-manned, and thus the manufacturers suffer no loss and practically no inconvenience by the system. There are two facts on which it is desired to place especial emphasis so that there may be no misunderstanding about this work. First, the entrance requirements for this course are precisely the same as for the regular four-year course. Secondly, the university instruction under the co-operative plan is just as complete, thorough, broad, and cultural, as the four-year course. As a matter of fact, it is broader and more cultural. Let there be no misunderstanding about this. The course is not a short-cut to a salary.

"The length of the course is six years. During this time the students work alternate weeks in the shops of the city during the scholastic year, and in the summer full time. They are given one week vacation at Christmas and two or three weeks during the summer. The practical work at the shops is as carefully planned as the theoretical work at the university, and in all cases the students follow, as nearly as possible, the path of the machines manufactured, from the raw material to the finished product sold. For instance, at the Bullock Electric Company the students spend the first year in the foundry, the next year and a half in the machine shop, the next two years in the graduate-apprentice course, covering the commutator, controller, winding, erecting, and testing departments, and the subsequent time in the drafting-room and sales office. A contract is signed in triplicate by the student, the university, and the firm. This contract has a blank space to be filled out with the shop work the student is to receive during his six-year course. In all cases the dean of the engineering college and the professor of electrical, chemical, or mechanical engineering, as the case may be, confer with the manufacturers in planning this course of shop work, so that the young men get a logically and carefully planned shop and business training.

"The students are paid for their services on a scale of wages beginning at ten cents an hour and increasing at the rate of one cent an hour about every six months. The rate at which the first class started was lower than this, but on account of the quality of work which the young men did in the shops, the manufacturers made a voluntary increase which is equivalent to about four hundred dollars for the whole course. The student's total earnings in the six years will amount to about two thousand dollars.

"Young men desiring to enter this course are required to go to the shops in June or July preceding their entrance to the university. We believe that certain men are mentally, physically, and temperamentally adapted to engineering, and that the process of elimination which comes through this summer work weeds out the weaker ones and leaves us a residue which can be depended upon for results. . . . . .

"A comparison of the work of the four-year freshmen with that of the six-year freshmen during the past year is worth a moment's consideration. The six-year co-operative students, although working but one-half the time of the regular students, have done three-quarters of the work of these regular students, including all the mathematics and sciences of the freshman year; their average grades are 25 per cent. higher than those of the four-year freshmen. As a matter of fact, they have taken all the university work excepting three hours of English and three periods of shop work, and, of course, they have received much more shop work at the city plants than they would have covered at the university.

"This course applies to the departments of electrical, chemical, and mechanical engineering. It has not been found feasible to establish a co-operative course in civil engineering because the local conditions will not permit. The aim of the course is not to make a so-called pure engineer; it is frankly intended to make an engineer for commercial production. For the investigation spoken of in the forepart of this paper disclosed the fact that a great majority of the engineering graduates are employed in commercial production, whereas the present college courses do not contemplate anything other than that the college graduate will become a so-called pure engineer.

"I regret that the time will not permit a

further exposition of this course, for the experiences which we have had in one year's operation and in gathering our second class have taught us a great many things which I believe would be of interest to you. I should like, for instance, to point out in detail some of the following features: The advantage to the student of the extra two years of time for the assimilation of his theory; the effect of his shop work on his theoretical work; the solution of the problem of proper exercise for the student; the knowledge he obtains of the labor problem, and of time as being the very essence of commercial production; the fact that this course resolves itself down to a training in commercial production with a university training in the underlying science—for you will note that of the six years, four are spent in practical shop work, and that in the two years' actual time spent at the university the coöperative student gets more than the regular student does in four years."

"It is believed this system of education will furnish to the manufacturer a man skilled both in theory and in practice, and free from the defects concerning which so much complaint is made. It is not held, of course, that this method of training will supply full fledged engineers, aged 23 years, or thereabouts; but it is believed that it will provide a better preparation, a stronger foundation, for the successful practice of engineering. The qualifications which the engineering graduate should possess will be more nearly attained. He will be just as thoroughly grounded in the fundamental principles of science as he is under present conditions, but he will have greater facility in applying them to practical problems. He will be much more highly specialized, but not at the sacrifice of fundamentals. A knowledge of the achievements in other fields of engineering will result from his constant association with the best practice in electrical, mechanical, structural, and chemical engineering as exemplified in the construction of the co-operating works, in their methods of power generation and transmission, and in their processes of manufacture—his attention having been called to these details in the class room, and his observation of them having been checked by searching questions thereon. He will become familiar with business methods by constant contact with business conditions, supplemented by class room instruction and practical talks on business law. He will obtain a knowledge of men by working intimately with all sorts and conditions of men in his gradual rise through the various departments of the co-operating plants. The cultural part of his education will be planned to make him a man of good address and broad sympathies.

"And, finally, a combination of these conditions will teach him to do his best naturally and as a matter of course. It will start him on his life work with a symmetrical and uniform fundamental development which will continue evenly and make him a skilled engineer, a safe business man, and a broadly tolerant and intelligent citizen."

THE SITUATION ON THE RAND.

A DISCUSSION OF PRESENT ECONOMIC CONDITIONS ON THE RAND AND SUGGESTIONS FOR THEIR IMPROVEMENT.

John Yates—Chemical, Metallurgical and Mining Society of South Africa.

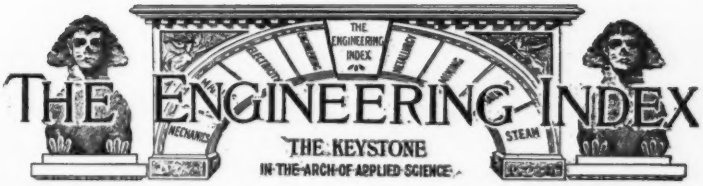
THE gold-mining industry on the Rand is at present in a more unsettled and depressed condition than at any other period in its history. Reports of the imminent exhaustion of the higher-grade ore have created an acute financial depression and the consequent shrinkage in the value of the shares of the mining companies is causing great public alarm in both South Africa and England. The situation is further complicated by the ever-present labor problem, in which the repatriation of the Chinese and an extensive strike are the most prominent factors, and by the unknown character of the new government which has recently come into power. All the presidential addresses of the South African technical societies which are just coming to hand emphasize the necessity for prompt and thorough revision

of the technical and economic conditions of the gold-mining industry before confidence and prosperity can be restored. The following extracts from the presidential address of Mr. John Yates before the Chemical, Metallurgical and Mining Society of South Africa give an interesting review of the present situation and outline the means by which it can be improved.

"And now you may be inclined to put to me that all absorbing question of the moment, how can the present acute depression, a depression which is wrecking the fortunes of so many, be removed and the future welfare of the country best assured? Remedies have been put forward from time to time, and they are again obtaining publicity before the Industrial Commissions at present sitting, and as it is largely reiteration, permit me to put them briefly: Reduce rents and bring down the cost of living; pull down freight charges, for cheap railway charges contribute largely to the development and prosperity of a country; lay out our new mines on an adequate scale and not on the kindergarten lines of the past; have large joint mills of even 1,000 stamps with centralised workshops, power station, and staffs to match; put down the minimum number of shafts; look upon labour saving devices with suspicion, for their promises are often better than their performances; afford our miners the opportunity of learning both the principles and practice of their profession; engage the Kafir on two years' contracts, and pay him a less wage for the work he does; give the miner and the Kafir each his proper sphere of work, the former using his intellectual gifts as a superintendent controlling the physical power of the coloured worker:—I submit that to have white men expending their energy on physical work which the much cheaper coloured labour is quite capable of performing is, on the face of it, absurd from a business point of view. Pay our miners a reasonable wage and let the scheme of pay be such as to encourage the men to develop and exhibit skill. See that underground supervision is made more effective, that small stopes are run by hand labour and large ones by ordinary sized machines; see that the healthiness of our working places receives due attention and insist on the miner using water jets, and plenty of water generally, to keep down dust. Workmen permanently resident in the country are desirable and, as suitable material is available, all that is necessary is its education and training. The married man has always been our best worker, so let us take care that our wage rate will suffice for his living here in comfort with his family and so induce him, if not a son of the country, to at least make it the land of his adoption. On the subject of our unskilled labour supply, the cause of such wordy strife here and such perturbation in Great Britain, I can only say that in view of the scarcity of natives practically ever since these goldfields were opened, the apparent impossibility of securing a sufficiency under the conditions hitherto obtaining, the finding of the many Commissions that have investigated this subject, the inability of the industry to forge ahead without an adequate complement, in view of these and other reasons I consider the Chinese an unfortunate necessity, but a necessity all the same, their importation has been an expensive experiment for the mines, and it is sincerely to be hoped that no unreasoning bias against this alien labour will be allowed to cripple the mines and the revenue of the country. Cool reasoning surely counsels that we will do well to retain the Chinese until the expected substitute has materialised, and if it so happens that this great importation experiment results in converting unbelievers to the actuality of our labour scarcity and gives rise to measures which will assure our mines an adequate supply of natives on suitable terms then I think it will be admitted that the silk-clad, luxury-loving, bicycle-riding, heathen Chinese has served a good purpose, and our mining houses will probably look upon the money as not having been spent in vain.

"I have here a classification of the mines of the Witwatersrand for September (1906), based upon their yield per ton milled. Out of the 65 mines then milling, 24 yielded not more than 30s., whilst the remaining 41 gave over 30s. Out of the total 65 mines 21 yielded between 25s. and 30s. and 20 gave between 30s. and 35s. Now these figures call for most earnest consideration. We are, as sensible business men,

at the present day working the rich, selected areas which offer us a profit, such areas as do not promise a due return for our capital and enterprise we naturally endeavour to avoid, though our efforts in this direction are not always successful. It may be assumed in a general way that most of the ground which offers an adequate profit under present economic conditions is being worked, and as this comprises only a small number of mines it follows that we have an immense tonnage of low grade banket on or near the outcrops as well as our great and almost intact deeper horizons of the reef, and all this reef, owing to the high cost of working, the average low grade, or the large capital which has to be risked, as yet remains largely unproved and unworked. Here I would say that I do not think that we have anything like conclusive proof of the falling away of value in depth so far as this field is concerned; in judging this matter allowance must be made for the fact that selection of stopes has been taking place, and still continues, in our existing properties. Are these low grade areas and deep zones to remain unexploited, is the country content, for instance, that only the present mines should work and working gradually fall out exhausted leaving the country to face serious financial straits only a few years hence? Surely not, and yet if this is not to be the case something of the nature of an economic revolution will have to be engineered to effect a lowering of costs, the augmenting of profits and the restoring of the confidence of the investing public. I have shown you how nearly 40 per cent. of our present mines, our selected rich areas, are not yielding more than 30s. per ton milled, and it is of interest to note that it has been recently estimated that 30s. per ton milled is probably the average value of all the unworked reef on the Rand. It is in essentially low grade rock that this country is rich, and it is the many golden miles of this rock that the country has to look forward to for sustenance in the years of the future. Our engineers have recently expressed the opinion that the best interests of the gold industry and the country call for a reduction of costs to about 16s. per ton milled. Now let us make every allowance for ulterior motives on their part, for even our mining engineers and financiers are not without them, let us examine their statement as critically as possible, and there will, I think, nevertheless remain a large majority of us who will agree with them that herein lies our present and future salvation, the return of prosperity, the solution of our white labour troubles, and the solid foundation upon which it will be possible to build the future of the country. Only by expansion is it possible, only by economic reform is expansion attainable, then, I say, let us have such reforms. And be it remembered that the working of very low grade ore will confer much greater benefit upon the country than upon the shareholders, the reward of the latter will be small indeed, but so long as profit is forthcoming will our gold beds be worked. Do not let our attention be distracted from the broader issues by such a comparatively small consideration, for instance, as labour ratios, this after all affects but a few of the many people in the land; do not let us, for the sake of the minority, sacrifice the majority by refusing to avail ourselves to the full of the country's rich asset of native labour, but let us earnestly and honestly assist in erecting an economic framework in the country which will stand as a fitting support for all future time. Our farming should be developed with all rapidity, our base metal and other industries should be encouraged, our present population must be provided with the wherewithal to live and settle in the country, and to do all this calls for the reforms mentioned. The country is called upon to select one of two paths —down the one there is a distant vista of a numerous and prosperous people with farming their chief vocation, substantially supported by the mining of gold, coal and base metals; down the other is seen a country undeveloped and forsaken of all but a few farmers, farmers without a market and content merely to live, a country of deserted towns and bankrupt in money and prestige, a country from which its very sons have fled to where progress holds sway. These are no idle visions, but they are, I believe, faithful outline pictures of the logical outcome of the adoption of the two policies open to the country; is it possible that we will ever see the latter one? Let us hope not."



The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

Civil Engineering	359	Mechanical Engineering	374
Electrical Engineering	366	Mining and Metallurgy	384
Industrial Economy	372	Railway Engineering	392
Marine and Naval Engineering	373	Street and Electric Railways	395

CIVIL ENGINEERING

BRIDGES.

Concrete Arch.

The Walnut Lane Bridge, Fairmount Park, Philadelphia. An illustrated description of the methods employed in constructing a concrete arch of 233 feet span. 4000 w. Eng Rec—Aug. 31, 1907. No. 86687.

Germany.

Some Notable German Bridges. F. C. Kuntz. Illustrated descriptions of beautiful bridges at Harburg, and at Mainz and other points on the Rhine. 1700 w. Sci Am—Aug. 31, 1907. No. 86677.

Highway.

Methods and Cost of Constructing Concrete Highway Bridges by Day Labor in Green County, Iowa. 1700 w. Engng-Con—Sept. 4, 1907. No. 86830.

Quebec.

The Fall of the Quebec Cantilever Bridge. An illustrated article giving the facts about the structure and its collapse, so far as at present known, with inter-

We supply copies of these articles. See page 397.

esting editorial. 10000 w. Eng News—Sept. 5, 1907. No. 86761.

The Quebec Bridge Collapse. An illustrated article, with report by H. M. Mackay on the collapse of the steel superstructure. 1500 w. Ir Age—Sept. 5, 1907. No. 86746.

The Quebec Bridge Disaster. An illustrated account of the collapse of this great cantilever bridge during construction, with short discussion of the possible cause. 3000 w. Engng—Sept. 6, 1907. No. 87076 A.

The Quebec Bridge. A brief illustrated description of this great cantilever structure, with editorial discussion of the collapse during construction. 4500 w. Engr, Lond—Sept. 6, 1907. No. 87082 A.

The Collapse of the Quebec Bridge. A statement of the facts thus far brought to light concerning this accident and the local conditions at the time. 5000 w. Eng Rec—Sept. 7, 1907. No. 86792.

The Fall of the Quebec Bridge. Gives drawings and essential data, illustration and editorial in regard to this failure. 6500 w. Eng News—Sept. 12, 1907. No. 87003.

The Quebec Bridge. Frank W. Skinner. An illustrated account of this important engineering work. Written previous to the disaster. 5700 w. Engng—Sept. 13, 1907. Serial. 1st part. No. 87210 A.

The Fall of the Quebec Bridge. Illustrations with brief notes. 500 w. Engng—Sept. 13, 1907. No. 87214 A.

The Quebec Bridge Disaster. An illustrated account of the fall of the cantilever bridge across the St. Lawrence, with editorial. 3500 w. Sci Am—Sept. 14, 1907. No. 86895.

The Fall of the Quebec Bridge. Editorial on two facts brought out recently which add to the information concerning the cause of the collapse. Drawings. 1500 w. Eng News—Sept. 19, 1907. No. 87117.

The Suspended Falsework of the Cantilever Arms of the Quebec Bridge. Illustrated description of the suspended falsework used in the erection. 2000 w. Eng Rec—Sept. 21, 1907. No. 87154.

Reinforced Concrete.

The New Stanford Bridge, Worcestershire. Illustrated description of the longest-span ferro-concrete arch hitherto built in Great Britain. 2000 w. Engng—Aug. 23, 1907. No. 86727 A.

Skew.

Skew Bridge of Reinforced Concrete—Wabash Railroad. A bridge over the Sangamon River, near Decatur, Ill., is illustrated and described. 700 w. Ry Age—Sept. 6, 1907. No. 86800.

Steel.

The Kafue River Bridge on the Cape to Cairo Railroad. Brief illustrated account of the longest bridge in Africa, a steel structure of the open-lattice girder type. 1200 w. Sci Am Sup—Sept. 28, 1907. No. 87254.

Substructure.

The Substructure of the Dearborn Street Bridge, Chicago. Brief description of this bridge and of the character of the river bottom, which presents peculiarly difficult conditions, with illustrated description of cofferdams and construction work. 2500 w. Eng Rec—Sept. 14, 1907. No. 87024.

Suspension.

An Eye-Bar Suspension Bridge over the Aare from the Knechteninseli in Bern (Kettensteg über die Aare beim Knechteninseli in Bern). F. Ackermann. An illustrated description of the design of a steel foot-bridge of 55 metres span. 1200 w. Schweiz Bau—Aug. 31, 1907. No. 86960 D.

Viaducts.

Test of the Reinforced Concrete Viaduct of the Richmond & Chesapeake Bay Ry. An illustrated account of the tests made of a viaduct designed for a train of cars each weighing 150,000 lbs., with a factor of safety of 4. 1000 w. Eng Rec—Sept. 21, 1907. No. 87156.

The Erection of Las Vacas Viaduct. An illustrated article describing methods used in erecting the narrow gauge single track viaduct on the Guatemala Ry. 2000 w. Eng Rec—Sept. 14, 1907. No. 87029.

The Genesee River Viaduct, Erie R. R. Illustrated detailed description of a viaduct with a steel plate girder superstructure, 3,121 ft. long and about 120 ft. in height from the water level. 1200 w. Eng Rec—Aug. 31, 1907. No. 86692.

The New Steel Viaduct Between Kansas City, Mo., and Kansas City, Kan. Explains the conditions and gives an illustrated detailed description of this recently completed work. 4500 w. Eng News—Sept. 26, 1907. No. 87243.

Reinforced Concrete Viaduct—Richmond & Chesapeake Bay Railway. Illustrated detailed description of a viaduct of unusual type, being built on an electric line in Virginia. The Kahn system of reinforcing is used. 1400 w. Ry Age—Sept. 27, 1907. No. 87287.

CONSTRUCTION.

Arches.

Symmetrical Masonry Arches—Coefficients for Reactions and Moments at the Supports. Malverd A. Howe. Gives an analysis of stresses, and methods of finding the moments at the supports and coefficients. 1200 w. R R Gaz—Aug. 30, 1907. No. 86662.

We supply copies of these articles. See page 397.

Beam Deflection.

The Calculation of the Deflection of Beams by Graphical Integration (Le Calcul des Flèches des Poutres par l'Intégration Graphique). E. Aragon. A theoretical and mathematical description of the method. Ills. 7000 w. Serial. 2 parts. Génie Civil—Aug. 17 and 24. No. 86927 each D.

Chimney Collapse.

Fall of a 150-Ft. Reinforced Tile-and-Concrete Chimney at La Crosse, Wis. An illustrated account by W. E. Miller, with information from several other sources. 2000 w. Eng News—Sept. 5, 1907. No. 86760.

Concrete.

How to Prevent Failure in Concrete Construction. Dr. W. Michaelis, Jr. Gives the writer's views on the merits and limitations of cement and concrete and on the causes of failure in concrete construction, with suggestions for the prevention of such failures. 9000 w. Jour W Soc of Engrs—Aug., 1907. No. 87138 D.

Concrete Pipe.

Methods and Cost of Constructing a Reinforced Concrete Pipe for Carrying Water Under Pressure. Chester Wason Smith. Describes the construction of about 6,000 ft. of reinforced concrete pipe for carrying water under pressure, giving results attained and cost. Ills. 3000 w. Engng-Con—Sept. 11, 1907. Serial. 1st part. No. 86894.

Reinforced Concrete Pipe for Carrying Water Under Pressure. Chester Wason Smith. Describes the construction of about 6,000 ft. of pipe intended to carry water under pressure; also gives results and figures of cost. Ills. 4500 w. Pro Am Soc of Civ Engrs—Aug., 1907. No. 86639 E.

Concrete Towers.

Reinforced Concrete Towers. D. W. Krellwitz. Illustrates and describes the reinforced-concrete towers, 142 feet high, built to carry a transmission line across the Welland Canal, near St. Catherines, Ontario. 1500 w. Pro Am Soc of Civ Engrs—Aug., 1907. No. 86638 E.

Dams.

The Stresses on Masonry Dams. Editorial review of a recent paper by Prof. Karl Pearson. 2000 w. Engng—Sept. 13, 1907. No. 87212 A.

Completion of the Cross River Dam, Croton Water-Works System. An illustrated account of this masonry dam which is to impound about 9,000,000,000 gallons of water for the increased supply of New York City. 3000 w. Eng Rec—Sept. 14, 1907. No. 87025.

Earth Pressures.

The Bracing of Trenches and Tunnels, with Practical Formulas for Earth Pressures. J. C. Meem. Treats of the sheathing and bracing of trenches and tunnels in dry and water-bearing strata. Ills. 6000 w. Pro Am Soc of Civ Engrs—Aug., 1907. No. 86640 E.

Excavating.

Hints on Handling Wheeled Scrapers. Suggestions for operating scrapers so as to increase the amount of earth excavated. 1500 w. Engng-Con—Aug. 28, 1907. No. 86651.

Foundations.

Machinery and Methods for the Excavation of Sky-Scraper Foundations. T. Kennard Thomson. An illustrated description of methods used in construction of these foundations, and modern machinery for carrying on the work. 4500 w. Engineering Magazine—Oct., 1907. No. 87280 B.

Method of Constructing the Foundations for the Trust Company of America Building, New York City. Maurice Deutsch. An illustrated description of foundation work for a 25-story building in Wall St. 2800 w. Sch of Mines Qr—July, 1907. No. 86648 D.

Foundations. An informal discussion of the best system of construction on an alluvial deposit, materials, setting of concrete, etc. 3800 w. Pro Am Soc of Civ Engrs—Aug., 1907. No. 86644 E.

Foundation Work and Ground-Water Protection for the Enlargement of the Merchants' and Manufacturers' Bank at Berlin (Fundierung und Grundwasser-Abdichtung für den Erweiterungsbau der Bank für Handel und Industrie zu Berlin). Th. Gesztessy. An illustrated mathematical description of the design. 2500 w. Beton u Eisen—Aug., 1907. No. 86980 F.

Lighthouse.

The Fastnet Rock Lighthouse. An illustrated description of this granite structure on the S. W. coast of Ireland, and its erection, as described by C. W. Scott. 3500 w. Engr, Lond—Sept. 13, 1907. No. 87219 A.

Material Handling.

Some Ancient Methods of Lifting Stones and Timber. Clement E. Stretton. Describes mechanical contrivances used by the ancients. Diagrams. 2000 w. Sci Am Sup—Sept. 14, 1907. No. 86898.

Reinforced Concrete.

The McNulty Building, New York. A ten-story and basement, small-column, reinforced-concrete building on 52d St., New York City, is illustrated and described. 1200 w. Eng Rec—Sept. 14, 1907. No. 87026.

The Mushroom System of Reinforced

We supply copies of these articles. See page 397.

Concrete Building Construction. A. S. Malcolmson. Illustrated description of the system invented by C. A. P. Turner. 2300 w. Engng-Con—Sept. 4, 1907. No. 86829.

Roads.

Road Intersections Along the Grand Boulevard and Concourse, New York City. Describes the transverse roads under construction at Tremont Ave. and Kingsbridge Road as typical of all that are to be built. Ills. 1600 w. Eng Rec —Aug. 31, 1907. No. 86693.

Rules.

Revision of French Rules. Gives final version as applied to reinforced-concrete construction, with list of corrections made. 2500 w. Cement Age—Sept., 1907. No. 87136.

Sewers.

Constructing a Sewer Under the Brooklyn Subway. Describes the construction of a curved by-pass 290 ft. long, explaining the conditions and requirements. Ills. 2000 w. Eng Rec—Aug. 31, 1907. No. 86689.

Stresses.

Higher Structures. C. Derleth, Jr. Gives a discussion of the literature and a survey of American and English treatment for the analysis of complex framed structures, with remarks on the latest edition of the work of Professors Merriman and Jacoby. 3500 w. Cal Jour of Tech—Aug., 1907. No. 87097.

Tanks.

Strength of Air Pressure Tanks. Ira J. Owen. Formulæ and specifications for the construction of steel sprinkler pressure tanks, discussing causes of explosion. Ills. 2500 w. Ins Engng—Sept., 1907. No. 87223 C.

Tunnels.

Cost and Methods of Construction of Tunnel for Water Pipes Under Mystic River, Boston, Mass. Caleb Mills Saville. An illustrated description of the work with tables of itemized costs. 2500 w. Eng News—Sept. 26, 1907. No. 87245.

Subaqueous Tunnel at Detroit. Illustrated description of the method of construction, which consists of dredging a channel across the river, laying sections of tube in the ditch, filling around and over them with concrete, and then pumping out the water. 1500 w. Ry & Loc Engng—Sept., 1907. No. 86705 C.

The Present Condition of the Battery Tunnel Under the East River. From a report by George S. Rice to the Public Utilities Commission, detailing the present status of the work. 1500 w. Eng News—Sept. 19, 1907. No. 87116.

Underground Workings in New York City. H. T. Hildage. Considers especially work in soft ground and the methods used, illustrated by the large undertakings in progress in New York City. 6000 w. Engineering Magazine—Oct., 1907. No. 87283 B.

Underpinning.

A Combined Underpinning and Sheeting Job. Describes complicated work in the construction of a six-story steel-cage bank building at the S.-W. corner of Murray St. and Broadway, New York City. Ills. 2000 w. Eng Rec—Sept. 7, 1907. No. 86786.

Warehouse.

Newark Warehouse of the Central Railroad of New Jersey. Photograph, drawings, and description. 700 w. R R Gaz—Aug. 30, 1907. No. 86659.

Wind Pressure.

The Chance of a Hurricane. A. P. Trotter. A discussion of the maximum wind pressure to be adopted in investigating the effect of wind on buildings and engineering structures. 3000 w. Engng —Aug. 23, 1907. No. 86726 A.

MATERIALS OF CONSTRUCTION.

Brick Walls.

Strength and Fire Protection of Brick Walls. Alfred Stone. A discussion of the carrying capacity of brick walls, their ability to stand upright and resist wind pressure and vibration, and the fire resistance of brick walls of certain thicknesses. 2700 w. Ins Engng—Sept., 1907. No. 87222 C.

Cement.

Notes on the Le Chatelier Test. W. Lawrence Gadd. Gives facts in connection with the behavior of rotary-made cement, based on hundreds of tests by the Le Chatelier method, and showing that under present conditions it is possible for a false conclusion to be drawn. 2800 w. Engr, Lond—Sept. 13, 1907. No. 87216 A.

Simple Tests of Portland Cement. W. Purves Taylor. Gives simple tests, that can be made by small consumers, for soundness, time of setting, purity, and strength. 1500 w. Cement—Aug., 1907. No. 86833 C.

Concrete.

Effect of Steam Curing on the Crushing Strength of Concrete. A report of investigations made to determine the efficiency of this method, with conclusions. 1500 w. Eng News—Sept. 5, 1907. No. 86757.

The Permeability of Concrete and Methods of Waterproofing. Richard H. Gaines. Gives the result of an investigation being carried on by the N. Y. Board of Water Supply in their effort to perfect the materials and methods of construction for the new aqueduct for the city. Also editorial. 5000 w. Eng News —Sept. 26, 1907. No. 87250.

We supply copies of these articles. See page 307.

The Equipment and Work of the U. S. Government Concrete Testing Laboratory at St. Louis, Mo. Richard L. Humphrey. Information in regard to the tests being carried out. Ills. 1800 w. Engng-Con—Sept. 25, 1907. No. 87260.

Concrete Columns.

Concrete Column Tests. Arthur N. Talbot. Presented at meeting of the Am. Soc. for Test. Mat. Gives a summary of the results of tests made at the Univ. of Illinois. Ills. 3000 w. Cement Age—Sept., 1907. No. 87135.

Strength Tests of Hooped Concrete Columns. Abstract of results reported by Prof. A. N. Talbot to the American Society for Testing Materials. Ills. 2500 w. Eng News—Sept. 26, 1907. No. 87249.

Corrosion.

See Electrical Engineering, Electro-Chemistry.

Fireproofing.

Terra Cotta Fireproofing. A. S. Atkinson. On its wide application in building construction, giving statistics of fireproof construction in New York City. Ills. 2500 w. Ins Engng—Sept., 1907. No. 87224 C.

Forest Planting.

Some Cost Figures on Forest Planting for Railroad Purposes. E. A. Sterling. Gives some cost figures in regard to work done by the Pennsylvania Railroad. 900 w. Eng News—Aug. 29, 1907. No. 87157.

Mortar.

Mortar and Concrete Mixtures. William Challoner. Discusses lime and cement mortars and the conditions under which the materals are available, the methods of improving the binding qualities, the advantages conferred by the use of trass, cost, etc. 2500 w. Engr, Lond—Sept. 6, 1907. No. 87085 A.

Reinforced Concrete.

An Experimental Study of Reinforced Concrete in Compression. Translation from *Beton und Eisen*, of an article by Messrs. Schinke and Loeser, describing experiments made on small prisms and columns with the object of studying the effect of lateral reinforcing on the compressive resistance of concrete. 2000 w. Cement—Aug., 1907. No. 86832 C.

Ferro-Concrete and Examples of Construction. J. S. E. De Vesian. Read before the British Assn. Refers to the ancient use of concrete and the present condition of the old material, and discusses the theory of ferro-concrete. 1700 w. Ir & Coal Trds Rev—Aug. 23, 1907. No. 86742 A.

Steel Columns.

Stresses in Lattice Bars of Built Columns. Thomas H. Johnson. A study offered as a tentative suggestion, stating the assumptions. 1000 w. Eng News—Sept. 26, 1907. No. 87247.

Timber.

Some Problems in Wood Utilization in the United States. R. S. Kellogg. Considers the reduction of waste, economy in use, etc. Discussion. 3500 w. Jour W Soc of Engrs—Aug., 1907. No. 87137 D.

The Results of Tests on the Strength of Timber Made at the Imperial Forestry Institution at Mariabrunn (Ueber die an der k. k. forstlichen Versuchsanstalt Mariabrunn gewonnenen Resultate der Holzfestigkeitsprüfungen). Gabriel Janka. The first part of the serial describes the results establishing a relation between specific gravity and compressive strength. Ill. 4000 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—Aug. 9, 1907. No. 86971 D.

Timber Preservation.

Specifications for Creosoting Oregon Fir Piling and Bridge Timber, A. T. & S. F. Ry. A copy of the specifications of this company. 3000 w. Ry & Engng Rev—Sept. 21, 1907. No. 87173.

MEASUREMENT.

See under Civil Engineering, Construction, and Materials of Construction.

MUNICIPAL.

Manila.

The New Water and Sewerage Systems of Manila. Illustrates and describes interesting work under construction in the Philippines, including a rubble concrete masonry dam creating a reservoir with a capacity of about 2,000,000,000 gals., and a combination gravity and pumping sewerage system. 2500 w. Eng Rec—Sept. 14, 1907. No. 87027.

Pavements.

Brick Pavements in Paris, Ill. Statistics from specifications, with comments and remarks on the construction. 4000 w. Munic Engng—Sept., 1907. No. 87133 C.

Pavements. An informal discussion of whether the paving materials of the present will be used in the construction of the pavements of the future. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1907. No. 86645 E.

On Better Systems of Pavements for Streets and Roads from the Point of View of Efficiency and Economical Maintenance (Sui Migliori Sistemi di Pavimentazione delle Strade Comunali e Provinciali dal Punto di Vista della loro Efficacia e della piu Economica Manutenzione). Nicolo Valente. 4000 w. Rivista Gen d Ferrovie—Aug. 11, 1907. No. 86904 D.

Roads.

See Civil Engineering, Construction.

We supply copies of these articles. See page 397.

Sanitation.

The Work of the Sanitary District of Chicago; That Already Accomplished and Yet Contemplated Below the Controlling Works at Lockport. Isham Randolph. Ills. Discussion. 5000 w. Jour W Soc of Engrs—Aug., 1907. No. 87141 D.

Sewage.

Comparative Résumé of the Sewage Purification Tests at Columbus, Ohio. George W. Fuller. With discussion. 24700 w. Jour Assn of Engng Socs—Aug., 1907. No. 87225 C.

The Use and Abuse of Sewage Purification Plants. A. Elliott Kimberly. Read before the Ohio Engng. Soc. Discusses the question of protection afforded by such plants to rivers and bodies of water, and the causes of failure when this protection is not accomplished. 5400 w. Eng Rec—Aug. 31, 1907. No. 86691.

Sewers.

See Civil Engineering, Construction.

WATER SUPPLY.

Artesian Wells.

Artesian Wells in Australia. Editorial on the great artesian basin of Australia; its geology, characteristics, its great value, etc., and the legislation controlling it. 2000 w. Engng—Sept. 6, 1907. No. 87080 A.

Canal Sections.

The Effect of Changes in Canal Cross-Sections Upon Rate of Flow. F. W. Hanna. Develops formulæ for solving problems often occurring in irrigation work. 1500 w. Eng News—Sept. 26, 1907. No. 87246.

Carbonic Oxide.

The Importance of Carbon Dioxide in Water-Supply Projects (Die Bedeutung der Freien Kohlensäure im Wasserversorgungswesen). Hartwig Klut. A discussion of its hygienic and technical effects. 7700 w. Gesundheits Ing—Aug. 10, 1907. No. 86976 D.

Concrete Pipe.

See Civil Engineering, Construction.

Dams.

See Civil Engineering, Construction.

Filtration.

The Circular Tanks at the Lancaster Filtration Plant. Illustrates and describes the coagulating and softening tanks of unusual design and operation. 1200 w. Eng Rec—Sept. 14, 1907. No. 87030.

The Water Filtration Plant of Harrisburg, Pa. Illustrated description of the new plant for filtering Susquehanna river water and its operation. 3000 w. Munic Engng—Sept., 1907. No. 87132 C.

Hydraulic Formulae.

Hydraulic Formulæ: Development and Discussion. Develops a General Equation of discharge, and, from it, derives the various formulæ for flow through orifices and over weirs of the shapes usually considered. 6500 w. Sch of Mines Qr—July, 1907. No. 86647 D.

Intake.

An Infiltration Water-Works Intake Under the Ohio River. Describes an intake built of well point strainers buried in the sand bottom of the Ohio River which has been in successful operation nearly a year. Ills. 1600 w. Eng Rec—Aug. 31, 1907. No. 86688.

Irrigation.

Evaporation Losses in Irrigation. Samuel Fortier. Reviews studies recently made to determine the losses by evaporation in irrigation in the state of California. Ills. Also editorial. 4800 w. Eng News—Sept. 19, 1907. No. 87113.

Irrigation and Drainage Problem in Stanislaus Co., Cal. C. S. Abbott. Describes the irrigation system of the Modesto-Turlock district, the harm caused by too much water, and methods used to remedy the trouble. Ills. 1500 w. Cal Jour of Tech—Aug., 1907. No. 87095.

Irrigation in Western Canada. A report of the first Canadian Irrigation Convention, recently held at Calgary, Alberta. 3000 w. Engng—Aug. 30, 1907. No. 86872 A.

Pipe Line.

A 7-Ft. Steel Pipe Line at St. Louis. Describes the construction of this line, 19,634 ft. in length, in connection with the improvements to the water supply system of St. Louis, Mo. 1500 w. Eng Rec—Sept. 7, 1907. No. 86787.

Pipe Sizes.

A Solution of the Problem of Determining the Economic Size of Pipe for High-Pressure Water-Power Installation. Discussion of paper by Arthur L. Adams on this subject. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1907. No. 86641 E.

Pipe Tunnel.

See under Tunnels, Civil Engineering, Construction.

Pumping Tests.

See Mechanical Engineering, Hydraulics.

Purification.

Direct and Indirect Methods of Electrical Purification of Water. Henry Leffmann. Considers some of the processes that have come under the writer's notice, giving an illustrated description of a plant in operation on the Schuylkill River, Philadelphia. 1800 w. Jour Fr Inst—Sept., 1907. No. 87089 D.

The Water Purification and Softening Works at New Orleans, La. Illustrates and describes two plants for filtering and softening the Mississippi River water.

We supply copies of these articles. See page 397.

1500 w. Eng Rec—Aug. 31, 1907. No. 86690.

Rates.

Rates for Water Service. Dabney H. Maury. Presidential address to the Am. Water-Works Assn. Discusses the basis for fair rates. 2000 w. Munic Engng—Sept., 1907. No. 87134 C.

Reservoirs.

A Colorado Mountain Reservoir. R. M. Hosea. Deals with the Sugar Loaf reservoir near Leadville, giving its history, describing the construction, and giving cost. Ills. Discussion. 7000 w. Jour W Soc of Engrs—Aug., 1907. No. 87140 D.

Stream Pollution.

Court Decision Against the Pollution of a Brook in Dracut, Mass., by the American Woolen Co. An explanation of the case with the decision. 3500 w. Eng News—Sept. 5, 1907. No. 86756.

Supply.

Water Supply. An informal discussion of whether it is better policy to control water-sheds, or to rely upon filtration. 8800 w. Pro Am Soc of Civ Engrs—Aug., 1907. No. 86643 E.

Tanks.

See Civil Engineering, Construction.

Water Softening.

McKeesport's Water Softening Plant. Illustrated detailed description of a 10,000,000-gallon municipal plant under construction, to use the caustic lime and soda ash process. 2500 w. Munic Jour & Engr—Sept. 4, 1907. No. 86827 C.

The Beissel Water-Softener. Illustrates and describes an automatic water-softening apparatus. 1700 w. Engng—Aug. 30, 1907. No. 86870 A.

WATERWAYS AND HARBORS.

Appalachian Streams.

Southern Appalachian Streams. Charles E. Waddell. Considers their characteristics and prominent features, their utilization as power producers, etc. Ills. 3500 w. Jour Fr Inst—Sept., 1907. No. 87087 D.

Docks.

The First Lake Dock of Steel. Dwight E. Woodbridge. Gives elevation and sections, with description of details of the structure to be built at Two Harbors, Minn. 2000 w. Ir Age—Oct. 3, 1907. No. 87377.

Drainage Canal.

The Chicago-St. Louis Waterway. W. Frank M'Clure. An illustrated article giving information of recent developments with reference to this project. 1500 w. Sci Am—Sept. 21, 1907. No. 87125.

Dry Regions.

The Procuring of Water in Dry Regions (Die Gewinnung von Wasser in Trockenen Gegenden). Hermann Haedicke. An illustrated description of methods of procuring water where wells or surface water are not available. 3300 w. Gesundheits Ing—Aug. 3, 1907. No. 86975 D.

French Canals.

Canal Transportation in France. From the report of Consul-General Robert P. Skinner covering the co-operation of State and communities in the construction of French canals, the cost, and the comparative freight charges by canals, rivers and railways. 1200 w. Eng Rec—Sept. 14, 1907. No. 87031.

Georgian Bay Canal.

Completion of the Surveys for the Montreal, Ottawa, and Georgian Bay Ship Canal. J. A. McDonald. Information concerning this project based on the recently completed survey. 1300 w. Eng News—Oct. 3, 1907. No. 87426.

Salton Sea.

The Story of Salton Sea. An interesting account of the recent outbreak in the Colorado River on the southern border of California. 2500 w. Builder—Aug. 24, 1907. Serial. 1st part. No. 86712 A.

Transalpine Waterway.

A Transalpine Waterway (Eine Transalpine Wasserstrasse)? Jos. Riedel. Reviews the history of the project for a waterway through the Alps and examines its feasibility. 4000 w. Oest Wochenschr f d Oeffent Baudienst—Aug. 10, 1907. No. 86968 D.

MISCELLANY.

Channel Tunnel.

The Project for a Railway-Tunnel Connection between England and France under the English Channel (Das Projekt der Eisenbahn-Tunnelverbindung zwischen England und Frankreich unter dem Canal la Manche). E. A. Ziffer. Outlines the various projects which have been put forward and describes the tunnel recently suggested. Ills. 5000 w. Mitt d Ver f d Förd d Lokal u Strassenbahnwesens—Aug., 1907. No. 86930 F.

Earthquake.

The Effects of the San Francisco Earthquake of April 18, 1906, on Engineering Constructions. Continued discussion of reports of committees of the San Francisco Association of members of the Am. Soc. of Civ. Engrs. 15400 w. Pro Am Soc of Civ Engrs—Aug., 1907. No. 86642 E.

Wagon.

Strength Tests of a Contractor's Dumping Wagon. Summary abstract of a report of tests made by Prof. W. K. Hatt, at Purdue University, of a special type of dumping wagon. Ills. 1000 w. Eng News—Sept. 19, 1907. No. 87115.

We supply copies of these articles. See page 397.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

Atmospheric Absorption of Wireless Signals. R. A. Fessenden. Reports results of some experiments recently made. 600 w. Elec Rev, Lond—Sept. 6, 1907. No. 87058 A.

Radio-Telegraphic Convention. Extracts from the report of the Select Committee of the House of Commons on the progress thus far. 2000 w. Elec Engr, Lond—Sept. 6, 1907. Serial. 1st part. No. 87055 A.

The Radio-Telegraphic Station at Nauen, Germany. Illustrated detailed description of an interesting station on the Telefunken system. 2000 w. Elec Rev, N Y—Sept. 7, 1907. No. 86784.

Wireless Telegraphy (La Télégraphie sans Fil). P. Janet. A discussion of the scientific principles on which wireless telegraphy is based. Ills. 6000 w. Mem Soc Ing Civ de France—June, 1907. No. 86909 G.

Wireless Telegraphy and its Most Recent Advances (Die Drahtlose Telegraphie und ihre Jüngsten Fortschritte). Otto Nairz. A brief review of the development of wireless telegraphy, particularly describing the recent advances made in Poulsen's researches. Ill. 4000 w. Serial. 2 parts. Verkehrstech Woche u Eisenbahntech Zeitschr—Aug. 3 and 10, 1907. No. 86949 each D.

Radio-Telephony.

Wireless Telephony for the United States Navy. Herbert T. Wade. Explains the construction and operation of the De Forrest system, illustrating the instruments. 1600 w. Sci Am—Sept. 28, 1907. No. 87252.

Telautograph.

The Cerebotani Telautograph (Der Telautograph von Cerebotani). Hans Dominik. An illustrated detailed description of the mechanism, diagrams of connections, etc. 4000 w. Verkehrstech Woche u Eisenbahntech Zeitschr—Aug. 31, 1907. No. 86952 D.

Telegraphy.

A "New" Sounder. Illustrated description of Vyle's direct-reading polarized sounder. 1000 w. Elec Rev, Lond—Sept. 6, 1907. No. 87061 A.

Telephony.

Distortion in Telephonic Transmission. Louis Cohen. Maintains that the resistance varies with the frequencies. 600 w. Elec Wld—Sept. 21, 1907. No. 87169.

Capacity in Telephone Lines (Della Capacità in Telefonia). R. Salvadori. A theoretical discussion of its causes, effects, methods of measurement, etc. Ills. 3500 w. Elettricità—Aug. 9, 1907. No. 86900 D.

DISTRIBUTION.

Fuses.

Fuses. Dr. Georg J. Meyer. Abstract translation from *Elek. Zeit.* Gives results of investigations made of the heating and arcing of fuses. 2200 w. Elect'n, Lond—Aug. 30, 1907. No. 86863 A.

Notation.

Notation for Polyphase Circuits. Charles H. Porter. Gives a notation based essentially on lettering every junction and terminal on the diagram of connections, and on the use of two subscripts with every symbol of current or electromotive force or vector representing them. 2000 w. Elec Jour—Sept., 1907. No. 87130.

Regulations.

Electricity in Factories. A draft of the regulations proposed by the Home Office (England) for the generation, transformation, distribution, and use of electrical energy in premises. 2200 w. Elec Engr, Lond—Aug. 30, 1907. No. 86860 A.

The Generation, Transformation, Distribution, and Use of Electric Energy. A discussion of draft regulations sent out for examination by suppliers and users of electrical energy, with the object of securing a complete code under the Factory and Workshop Act in regard to works where electric energy is used. 1800 w. Elec Engr, Lond—Sept. 6, 1907. No. 87054 A.

Shop Equipment.

The 220-Volt Direct Current System of Distribution. Explains the advantages of this system for shop equipment. 1300 w. Elec Age—Aug., 1907. No. 86701.

Wiring Risks.

Electric Wiring Risks. Frank Broadbent. Notes on American and English practice. 2800 w. Elec Rev, Lond—Sept. 6, 1907. No. 87059 A.

DYNAMOS AND MOTORS.

Alternating-Current.

General Theory of Alternate-Current Motors. H. Görges. Abstract from *Elek. Zeit.* Explains the action of single and polyphase alternate-current motors, giving a classification based on the nature of the rotor currents. 2000 w. Elect'n, Lond—Sept. 13, 1907. No. 87209 A.

We supply copies of these articles. See page 397.

Armature Design.

The Influence of the Teeth and Grooves on the Armatures on Dynamo Operation (Der Einfluss der Zähne und Nuten auf die Wirkungsweise der Dynamoanker). Reinhold Rüdenberg. A theoretical and mathematical paper. Ills. 5000 w. Serial. 1st part. Elektrotech u Maschinenbau—Aug. 4, 1907. No. 86966 D.

D. C. Generators.

Three-Wire Direct-Current Generators. B. T. McCormick. Read before the Can. Elec. Assn. at Montreal. Gives briefly the principles of operation of three-wire generators, calling attention to some of their advantages. 1000 w. Elec Rev, N Y—Sept. 28, 1907. No. 87303.

Dynamo Dimensions.

A Method of Determining the Leading Dimensions of Large and High-Speed Continuous Current Dynamos. H. M. Hobart and A. G. Ellis. Describes a method based on a general relation between the leading dimensions, armature strength, number of poles, rated output and speed, and the commutating quality. 1200 w. Elec Rev, Lond—Sept. 6, 1907. Serial. 1st part. No. 87060 A.

Induction Motors.

Fractional Pitch Windings for Induction Motors. C. A. Adams, W. K. Cabot, and G. Æ. Irving, Jr. Reports an investigation made to develop a method by means of which the effects of such windings may be calculated. 4000 w. Pro Am Inst of Elec Engrs—Aug., 1907. No. 87143 D.

Losses.

The Experimental Determination of the Losses in Motors. C. F. Smith. Abstract of a paper read before the Manchester Loc. Sec. of the Inst. of Elec. Engrs. Describes the methods in use for obtaining a separate determination of the iron and friction losses, in both continuous and alternating-current motors, and discusses the advantages and disadvantages of the various methods. 2500 w. Elect'n, Lond—Aug. 30, 1907. Serial. 1st part. No. 86865 A.

Railway Motors.

See under Motors, Street and Electric Railways.

ELECTRO-CHEMISTRY.

Cells.

Mercurous Sulphate, Cadmium Sulphate, and the Cadmium Cell. G. A. Hulett. From the *Phys. Rev.* Describes a series of experiments made on cadmium cells, and gives the results of some experiments with regard to the ageing of standard cells. 4000 w. Elect'n, Lond—Sept. 6, 1907. No. 87066 A.

Conductivity.

On the Conductivity of Electrolytes in Pyridine and Other Solvents. Kenneth Somerville Caldwell. A report of experimental work carried out in Leipzig under the direction of Prof. A. Hantzsch. 800 w. Elec Engr, Lond—Aug. 30, 1907. No. 86859 A.

Corrosion.

The Electrolytic Theory of the Corrosion of Iron. Dr. Allerton S. Cushman. A study of the real cause of iron rust. 3000 w. Sci Am Sup—Aug. 31, 1907. Serial. 1st part. No. 86681.

Corrosion of Iron. Abstracts of papers by Dr. Allerton S. Cushman, and by Dr. William H. Walker, Anna M. Cederholm, and Leavitt N. Bent, with editorial comment. Deals with the causes of corrosion and means of overcoming the troubles due to it. 5500 w. Elec-Chem & Met Ind—Sept., 1907. No. 86839 C.

The Corrosion of Iron: Rusting. An outline of some of the experiments and applications of the electrolytic theory, as given in papers by Allerton S. Cushman, and Prof. W. H. Walker, with interesting comparison of the various theories. 3300 w. Eng News—Sept. 26, 1907. No. 87244.

Electrolysis.

Influence of Iron in Copper Electrolysis. E. L. Larson. Gives results showing the retardation of varying amounts of iron, and the effect of other influences. 1200 w. Eng & Min Jour—Sept. 7, 1907. No. 86807.

Electrolytic Assaying.

The Results of Researches on Electrolytic Analysis (Elektroanalytische Forschungsergebnisse). Franz Peters. A review of the progress of knowledge and methods of the electrolytic determination of metals, the first part of the serial giving a general, historical introduction to the subject. 7000 w. Serial. 1st part. Glückauf—Aug. 17, 1907. No. 86940 D.

Electro-Metallurgy.

Applied Electro-Metallurgy Up to the End of 1906. John B. C. Kershaw. A summary of the various electro-metallurgical industries, describing briefly the processes and methods in use. Ills. 3000 w. Engineering Magazine—Oct., 1907. Serial. 1st part. No. 87281 B.

See also Mining Engineering, Iron and Steel.

Gold Deposition.

Heavy Gold Deposits and a Good Solution for Producing Them. 2000 w. Brass Wld—Sept., 1907. No. 87187.

Gold Recovery.

The Electrolytic Recovery of the Gold from Rolled Gold-Plate Scrap. Describes the method of electrolytic refining used because of its economy. Ills. 2500 w. Brass Wld—Sept., 1907. No. 87185.

Nitrogen.

The Fixation of Nitrogen. Norman Whitehouse. An account of a research

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carried out to obtain a workable commercial process by which nitrogen of the atmosphere could be obtained combined as ammonia or nitrate. 2500 w. Elec-Chem & Met Ind—Sept., 1907. No. 86838 C.

Electrothermic Combustion of Atmospheric Nitrogen. Abstract of a paper by F. Howles, giving an interesting résumé of the chief processes employing electric discharges through air. 3000 w. Elec-Chem & Met Ind—Sept., 1907. No. 86836 C.

The Formation of Compounds of Nitrogen and Oxygen from the Air by Electricity (Die Darstellung von Stickstoff-Sauerstoff-Verbindungen aus Atmosphärischer Luft auf Electrischem Wege). Dr. B. Springfeldt. A description of various devices and processes for the fixation of atmospheric nitrogen. Ills. 1500 w. Serial. 1st part. Elektrochem Zeitschr—Aug., 1907. No. 86948 G.

Oxygen.

The Commercial Preparation of Oxygen and Hydrogen (Per la Preparazione Industriale dell' Ossigeno e dell' Idrogeno). An illustrated description of a new device for the production of hydrogen and oxygen by the electrolysis of water. 1700 w. Serial. 1st part. Il Monit Tech—Aug. 10, 1907. No. 86906 D.

ELECTRO-PHYSICS.

Conductors.

Forces in the Interior of an Electric Conductor. Edwin F. Northrup. Abstract from *Phys. Rev.* Describes experiments for showing the forces existing in the interior of conductors when traversed by a current, and considers their magnitude theoretically. 4500 w. Elect'n, Lond—Sept. 13, 1907. No. 87206 A.

Mechanical Action of Currents on Conductors. P. Bary. Abbreviated translation from *L'Eclair Elec.* Describes experiments which show that when a current passes through a conductor certain mechanical forces are set up causing a stricture effect. Ills. 3500 w. Elect'n, Lond—Sept. 6, 1907. No. 87064 A.

Magnets.

The Design of Plunger Magnets. C. P. Nachod. Shows the relation between the pull and the diameter of the plunger, and other properties of the magnets. 800 w. Elec Wld—Sept. 21, 1907. No. 87168.

GENERATING STATIONS.

See also under Street and Electric Railways.

Azores.

Electricity in the Azores. Illustrated description of the three hydro-electric stations which furnish electricity for lighting and power. 1200 w. Engr, Lond—Aug. 30, 1907. No. 86875 A.

Charges.

Some Fundamental Principles Underlying the Sale of Electrical Energy. Clarence P. Fowler. Discusses the main features upon which rates should be based, illustrating by an example. 3000 w. Elec Wld—Sept. 7, 1907. No. 86845.

Excitation.

Some Notes on the Excitation of Power Units. Discusses direct-current generators, and alternators, and methods of excitation. 1500 w. Elec Rev, Lond—Sept. 13, 1907. No. 87205 A.

Hydro-Electric.

The Hydro-Electric Development of the Great Northern Power Co. The first of a series of articles giving an illustrated detailed description of this development on the St. Louis River, near Duluth, Minn. 5500 w. Eng Rec—Sept. 7, 1907. Serial. 1st part. No. 86785.

The Hydro-Electric Plant at Kakabeka Falls, Ont. Illustrated detailed description. 2500 w. Can Elec News—Sept., 1907. No. 86820.

The Hydro-Electric Plant of the Canadian Niagara Power Company. A brief illustrated description of the plant and its operation. 3000 w. Can Elec News—Sept., 1907. No. 86822.

The Hydro-Electric Plant of the McCall Ferry Power Co. Illustrated detailed description of the design and methods of construction for a plant with a nominal capacity of 100,000 h. p. 6500 w. Eng Rec—Sept. 21, 1907. No. 87153.

The McCall Ferry Hydro-Electric Power Plant on the Susquehanna River. Illustrated detailed description of the construction of this large plant, and the methods of carrying out the work. The whole plant is essentially a concrete structure. 7500 w. Eng News—Sept. 12, 1907. No. 87000.

The Brusio Hydro-Electric Plant and the Transmission of Power in Lombardy (Impianto Idroelettrico di Brusio e Trasporto di Forza in Lombardia). An illustrated description of an interesting plant in Italy, the construction of which was much complicated by its inaccessibility. 2000 w. Serial. 1st part. Elettricità—Aug. 16, 1907. No. 86901 D.

Hydro-Electric Plants on the Mediterranean Coast (Installations Hydro-Electriques de L'Energie Electrique du Littoral Méditerranéen). E. de Marchena. Illustrates and describes power plants and transmission lines in the southern part of France. 12000 w. Mem Soc Ing Civ de France—July, 1907. No. 86911 G.

Hydro-Electric Power Developments in France (Les Usines Hydro-Electric en France). G. de Lamarcodie. An article descriptive of the immense development of electrical energy from water powers,

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outlining the uses to which it is put in the several parts of the country. Ills. 8000 w. Rev Gen d Sci—Aug. 30, 1907. No. 86920 D.

Loads.

A Suggestion for the Improvement of the Small Power Load. H. S. Hatfield. Considers the sub-meter system, illustrating and describing a type of meter. 1000 w. Elect'n, Lond—Sept. 13, 1907. No. 87207 A.

Oil-Engine Driven.

Oil-Engine Driven Power Plant of the Pittsfield Electric Company. Illustrated description of a plant driven by Diesel engines. 1500 w. Elec Wld—Sept. 7, 1907. No. 86842.

Rio de Janeiro.

Electrical Developments in Rio de Janeiro. Plans and description of the Rio das Lages power plant, and information of the possible developments of electrical power and lighting. 2000 w. Elec Rev, Lond—Sept. 6, 1907. No. 87057 A.

Storage Batteries.

The Application of the Storage Battery to Lighting, Power, and Railway Service. J. M. S. Waring. Considers means of controlling the charge and discharge of batteries; and the results accomplished by the batteries in their various applications. Discussion. Ills. 7000 w. Jour W Soc of Engrs—Aug., 1907. No. 87139 D.

The Trend of Storage Battery Development. L. H. Flanders. Considers only storage batteries designed for stationary use, describing an installation. Ills. 2200 w. Elec Jour—Sept., 1907. No. 87131.

Substations.

A Note on Sub-Station Cable Arrangement. W. Pleasance. Notes on methods of securing a regular arrangement of cables inside the sub-station to avoid confusion, waste, and dangerous troubles. 600 w. Elec Engr, Lond—Sept. 6, 1907. No. 87056 A.

Sub-Station Troubles. A. Wohlgemuth. Considers troubles caused by a breakdown at the generator plant, and causes and effects of local troubles. 2400 w. Power —Oct., 1907. No. 87265 C.

Three-Phase Power Supply of the Manchester Corporation. Gives a typical sub-station plan for alternating-current supply only, describing the method. Ills. 1800 w. Elect'n, Lond—Aug. 23, 1907. Serial. 1st part. No. 86722 A.

Synchronizing.

Synchronizing. Paul MacGahan and H. W. Young. Illustrates and describes types of synchronizing devices. 3000 w. Elec Jour—Sept., 1907. No. 87129.

LIGHTING.

Arc Lamps.

Recent Developments in Metallic Flame Arc Lamps. G. Brewer Griffin. Describes direct-current lamps for operation in series, designed for street-lighting service. Ills. 2500 w. Elec Rev, N Y—Sept. 14, 1907. No. 87022.

The Flaming Arc Lamp. J. H. Hallberg. Reviews the development and present efficiency of arc lamps. 2000 w. Elec Rev, N Y—Sept. 14, 1907. No. 87013.

New Developments in Arc Lamps and High-Efficiency Electrodes. George M. Little. A comparison between metallic and carbon arcs. 2500 w. Sci Am Sup—Aug. 31, 1907. No. 86682.

New Methods of Suspending Arc Lamps (Neuerungen auf dem Gebiete der Bogenlampen—Aufhangungen). R. Osterburg. Illustrates and describes a large number of devices. 3000 w. Serial. 1st part. Elektrotech Zeitschr—Aug. 15, 1907. No. 86990 D.

Diffused Light.

The Elements of Inefficiency in Diffused Lighting Systems. Preston S. Millar. Read before the Ill. Engng. Soc. Considers the elements of inefficiency in lighting systems of this character, basing most of the conslusions upon measurements of illumination intensity. 3000 w. Pro Age—Sept. 2, 1907. No. 86665.

Factories.

Factory Lighting. Abstract of a paper by A. P. Biggs, read before the Ohio Elec. Lgt. Assn. Considers the sources of light now available and their merits, cost, etc. 4000 w. Eng Rec—Sept. 21, 1907. No. 87151.

Germany.

Electric Lighting in Germany. Dr. Phillip G. Klingenberg. Gives a review of the general aspects of electric lighting in Germany. 4500 w. Elec Rev, N Y—Sept. 21, 1907. No. 87159.

Helion Lamps.

The Helion Light. Walter G. Clark. An account of the Helion filament by one of the discoverers, stating the advantages claimed. 1800 w. Elec Rev, N. Y.—Sept. 14, 1907. No. 87015.

The Helion Lamp. Walter G. Clark and Herschel C. Parker. Describes the development of the Helion filament and the method of making it, explaining its characteristics. 1800 w. Sch of Mines Qr —July, 1907. No. 86649 D.

Illumination.

Recent Advances in Artificial Lighting. An illustrated article considering recent developments in lamps for out-door use, or for very large interiors. Arc and vacuum-tube electric lamps. 5500 w. Eng News—Sept. 12, 1907. No. 87002.

Some Artistic Requirements of Artificial Illumination. Bassett Jones, Jr. Discusses the considerations that must gov-

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ern the design of an architectural lighting scheme. 2500 w. Elec Rev, N Y—Sept. 14, 1907. No. 87018.

The Engineering of Show-Window Illumination. J. R. Cravath and V. R. Lansingh. Discusses the lighting of windows for the purpose of displaying goods at the best advantage. 3300 w. Elec Wld—Sept. 7, 1907. No. 86843.

The Status of Illuminating Engineering. Dr. Louis Bell. Discusses the requirements of illuminating engineering as a profession. 1500 w. Elec Rev, N. Y—Sept. 14, 1907. No. 87009.

Incandescent Lamps.

Incandescent Lamp Development During the Last Twenty Years. S. E. Doane. A resumé of interesting features in the development. 3500 w. Elec Rev, N Y—Sept. 14, 1907. No. 87010.

The Recent Incandescent Lamp Developments and Their Significance. Francis W. Willcox. A review of recent improvements in metallic filaments, showing that many important changes are in progress. Ills. 4500 w. Elec Rev, N Y—Sept. 14, 1907. No. 87011.

The Effect of Higher-Efficiency Lamps on Station Output and Income. A symposium from central station men in the United States and Great Britain. 2500 w. Elec Rev, N Y—Sept. 14, 1907. No. 87014.

The "Turn-Down" Electric Lamp. A. Frederick Collins. Reviews the various types of "turn-down" lamps invented, explaining their construction. Ills. 1500 w. Sci Am—Sept. 21, 1907. No. 87126.

The Sirius Colloid Lamp. Paul McJunkin. Describes this lamp and its behavior. 800 w. Elec Rev, N Y—Sept. 14, 1907. No. 87016.

Mercury Vapor.

The Mercury Vapor Lamp as a Factor in Electricity Supply Development. Discusses the merits of the mercury vapor lamp and its practical application, illustrating some forms recently brought out. 2000 w. Elec Rev, Lond—Aug. 23, 1907. No. 86721 A.

The Mercury Vapor Lamp. Percy H. Thomas. Gives an outline of the form and characteristics of this illuminant, stating its advantages and limitations. 3500 w. Elec Rev, N Y—Sept. 14, 1907. No. 87021.

The Development of the Mercury-Vapor Lamp (Die Entwicklung der Quecksilberlampe). Dr. Br. Glatzel. Outlines the development of the mercury-vapor lamp, illustrates and describes various existing types, and discusses their utility. 3000 w. Verkehrstech Woche u Eisenbahntech Zeitschr—Aug. 24, 1907. No. 86950 D.

Moore Light.

The Moore Light and Illuminating Engineering. D. McFarlan Moore. An illustrated article describing the Moore tube-lighting system. 2000 w. Elec Rev, N Y—Sept. 14, 1907. No. 87023.

Nernst Lamps.

The Nernst Glower and the Present Status of the Nernst Lamp. Otto Foell. Describes characteristics of the Nernst lamp and details of new applications. Ills. 3500 w. Elec Rev, N Y—Sept. 14, 1907. No. 87020.

Rates.

The Sale of Electricity for Lighting Purposes Commercially Considered. L. E. Buckell. Suggestions for electric light salesmen, based on conditions in England. 1500 w. Elec Engr, Lond—Sept. 13, 1907. No. 87180 A.

Residences.

Economical House Lighting. Van Rensselaer Lansingh. Considers the lighting of houses where good, economical illumination and artistic effects are desired. Ills. 2000 w. Elec Rev, N Y—Sept. 14, 1907. Serial. 1st part. No. 87012.

Standards.

Primary, Secondary, and Working Standards of Light. Dr. Edward P. Hyde. Read before the Ill. Engng. Soc. Considers practical questions in connection with the relationship of primary, secondary, and working standards of light. 1700 w. Pro Age—Sept. 2, 1907. No. 86664.

Tungsten Lamps.

The Economy of the Tungsten Lamp. Alfred A. Wohlauer. A critical discussion of the relations between initial cost of the lamp, its life and its efficiency, price of energy, etc. 2000 w. Elec Wld—Sept. 7, 1907. No. 86844.

MEASUREMENT.

Alternator Tests.

Report on Test of 1,000 K. W. B. T. H. Turbo-Alternator Set Made at Contractors' Works, Rugby. Illustration, with results of an official test on a Curtis steam-turbine, driving a two-phase alternator. 600 w. Elec Engr, Lond—Sept. 13, 1907. No. 87179 A.

Frequency Meters.

Induction Type Frequency Meters. Paul MacGahan and H. W. Young. Brief illustrated description of the Graphic Recording Frequency Meter and its operation. 2000 w. Elec Age—Aug., 1907. No. 86702.

A New Frequency Meter for Wireless Telegraphy (Ein Neuer Frequenzmesser der Strahlentelegraphie). Eugen Nesper. Illustrated detailed description. 2000 w. Verkehrstech Woche u Eisenbahntech Zeitschr—Aug. 24, 1907. No. 86951 D.

Galvanometer.

Observation of Alternate Currents with

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the String Galvanometer. Gyözö Zemplén. Trans. from *Phys. Zeit.* Describes the writer's work with a small string galvanometer in measuring alternating currents. 900 w. Elect'n, Lond—Sept. 6, 1907. No. 87065 A.

High Frequency.

A Universal Instrument for High-Frequency Measurements (Ein Universal-Messinstrument der Hochfrequenz-Technik). Eugen Nesper. Illustrated detailed description of instrument and method of use. 2800 w. Serial. 1st part. Elektrotech Zeitschr—Aug. 29, 1907. No. 86991 D.

Hysteresis.

On a Method of Plotting the Hysteresis Loop for Iron with an Application to a Transformer. Dr. Gisbert Kapp. An explanation of method. 800 w. Elec Age—Sept., 1907. No. 87262.

Instruments.

Instruments for Testing Direct-Current Machinery. E. S. Lincoln. Gives an outline of important tests and instructions for carrying them out. 2000 w. Power—Sept., 1907. No. 86675 C.

Electrical Measuring Instruments. Explains properties which may be utilized in designing ammeters, voltmeters, and wattmeters. 1500 w. Ry Loc Engng—Sept., 1907. No. 86706 C.

Photometry.

Photometric Units. Preston S. Millar. Discusses the nomenclature used in photometry in the United States, and the system of units adopted at the Geneva Congress. 1700 w. Elec Rev, N Y—Sept. 14, 1907. No. 87019.

Photometry at the Bureau of Standards. Dr. Edward P. Hyde. Illustrated description of the photometric equipment and methods of testing and investigating. 3500 w. Elec Rev, N Y—Sept. 14, 1907. No. 87017.

The Application of the Spherical Photometer (Zur Anwendung des Kugelphotometers). R. Ulbricht. An illustrated mathematical paper on the use of the Ulbricht photometer. 4500 w. Elektrotech Zeitschr—Aug. 8, 1907. No. 86988 D.

Switchboard.

A Testing Switchboard. Describes the general arrangement of a board designed for testing direct-current motors and dynamos. Ills. 1000 w. Elec Rev, Lond—Aug. 30, 1907. No. 86861 A.

TRANSMISSION.

Concrete Towers.

See Civil Engineering, Construction.

European Lines.

Some Examples of Power Transmission in Central Europe (Quelques Transports d'Energie de l'Europe Centrale). Alfred Lambotte. Illustrates and describes hydro-electric, steam and gas power stations and transmission lines in Central Europe, the information being collected during an extensive tour. 40000 w. Soc Belge d'Elec'ns—Aug., 1907. No. 86912 E.

High Voltage.

A Year's Operation of the Highest Working Voltage in the World. F. E. Greenman. Read at the Mich. Elec. Assn. Con. Brief account of the operating of the Grand Rapids-Muskegon Power Company's transmission line at 72,000 volts. Ills. 1200 w. Elec Wld—Sept. 14, 1907. No. 87036.

Insulators.

High-Tension Insulators, from an Engineering and Commercial Standpoint. C. E. Delaneld. Read at Montreal meeting of the Can. Elec. Assn. Discusses the requirements of insulators for high voltages. 3000 w. Elec Rev, N. Y—Sept. 28, 1907. No. 87301.

Lightning Protection.

Discussion on "Lightning Phenomena in Electric Circuits," "Protection Against Lightning, and the Multigap Lightning Arrester," and "New Principles in the Design of Lightning-Arresters" at New York, March 29, 1907. Papers by Charles P. Steinmetz, D. B. Rushmore, D. Dubois, and others, are discussed. 8000 w. Pro Am Inst of Elec Engrs—Aug., 1907. No. 87147 D.

Line Calculations.

The Calculation of Transmission Lines. Harold Pender. Gives formulæ and tables devised to furnish a simple and accurate method for making the necessary calculations. 1500 w. Elec Age—Sept., 1907. No. 87261.

Lines.

The 50,000-Volt Line of the Taylor's Falls-Minneapolis Power Transmission. Illustrated description of this pole line 40.6 miles long, designed to carry the total present capacity of the plant. 1300 w. Elec Wld—Sept. 7, 1907. No. 86841.

Wood Pole Line Construction. A. B. Lambe. Discusses in detail the main and standard points in wood pole line construction. 6500 w. Can Elec News—Sept., 1907. No. 86821.

Single-Phase Catenary Line Construction. G. D. Nicoll. Read before the Cent. Elec. Ry. Assn. Deals with a catenary construction for the operation of high-voltage alternating-current electric railways. 1200 w. Elec Ry Rev—Sept. 28, 1907. No. 87299.

Transformers.

Abnormal Primary Current and Second Voltage on Placing a Transformer in Circuit. Trygve Jensen. Gives results of investigations made of the values of the primary current and the secondary e. m. f. when the primary circuit of a transformer

is closed at different pre-determined time-phase positions of the supply e. m. f. 1600 w. Elec Wld—Sept. 14, 1907. No. 87033.

Outline of the Characteristics of Constant Potential Transformers. George A. Burnham. Outlines briefly the important factors and considers the action of the simple transformer. Diagrams. 1800 w. Elec Wld—Sept. 7, 1907. No. 86846.

The Design of Transformers as Influenced by the Employment of Alloy-Sheets. Dr. Robert Pohl. Abstracted from *Elek. Zeit.* Proves that the use of alloy-sheets for smaller sizes of transformers leads to increased efficiency, reduced cost and weight of active material. 600 w. Elect'n, Lond—Sept. 13, 1907. No. 87208 A.

The de Faria Electrolytic Transformer. O. de Faria. An illustrated description of design, construction, and operation, with results of tests. 3200 w. Bull Soc d'Encour—July, 1907. No. 86918 G.

MISCELLANY.

Argentina.

Electrical Development in Argentina. Lewis R. Freeman. Facts elicited from prominent residents of Mendoza during a recent visit in regard to power development possibilities. Ills. 1800 w. Elec Wld—Sept. 14, 1907. No. 87034.

Matter.

The Kinetic Theory of Matter (Die Kinetische Theorie der Materie). Dr. G. Jäger. An exposition of the kinetic theory of matter as held by the physicists in the present controversy between physicists and chemists. 4500 w. Zeitschr d Oest Ing u Arch Ver—Aug. 16, 1907. No. 86973 D.

Peru.

Electricity in Peru. Emilio Guarini. An illustrated article giving an account of the electrical development and the favorable conditions for the application of electricity. 2000 w. Elec Wld—Sept. 14, 1907. No. 87035.

Plant Growth.

Effect of Electricity Upon Plants. J. H. Priestly. Abstract of a paper read before the British Naturalists' Soc. Gives results of experiments with the overhead discharge system of electrification; also with earth currents. 3000 w. Elect'n, Lond—Sept. 6, 1907. No. 87063 A.

INDUSTRIAL ECONOMY

Apprenticeship.

A Model Apprenticeship System. Magnus W. Alexander. On the General Electric Company's system as established at Lynn, Mass. 2200 w. Ir Age—Sept. 19, 1907. No. 87103.

Arbitration.

Arbitration: Compulsory and Voluntary. Discusses the failure of compulsory arbitration in Australia. 2500 w. Min & Sci Pr—Sept. 7, 1907. No. 86892.

Canadian Branches.

United States Manufacturers in Canada. Edward Porritt. Condensed from Boston *Transcript.* On the causes that have led to the establishment of branches of American industrial concerns in Canada. 2800 w. Ir Age—Sept. 26, 1907. No. 87229.

Coal Lands Tax.

The Proposed Tax on Anthracite Coal Lands. Editorial discussion of this tax, showing it to be unjust. 1500 w. Mines & Min—Sept., 1907. No. 86769 C.

Commerce of U. S.

Commerce of the United States by Principal Ports and Sections, 1907. Some recent statistics and comparisons showing the trend of the import and export trade. 1800 w. Sci Am Sup—Aug. 31, 1907. No. 86680.

Copper Industry.

The Copper Situation in the United States. James Douglas. Gives a review of the sources of supply and demand and a study of the present position and economic outlook. 6000 w. Engineering Magazine—Oct., 1907. No. 87275 B.

Cost Keeping.

A Perfect Cost System. F. E. Webster. The twelfth and final article of a series on cost keeping. 2000 w. Ir Trd Rev—Sept. 5, 1907. No. 86774.

Education.

Commercial Training Workshops. Charles Prescott Fuller. Gives an outline of a course of training which the writer believes would best fit the youths for the exacting requirements of the future. 2500 w. Am Mach—Vol. 30, No. 37. No. 86887.

Education for Industrial Workers. Arthur D. Dean. A plea for a machine trade school giving a suggested outline. 3500 w. Mach, N Y—Sept., 1907. No. 86749 C.

Co-operative Courses in Engineering at the University of Cincinnati. Herman Schneider. Read before the Soc. for the Pro. of Engng. Ed. An account of a course in which students work alternate weeks in the engineering college of the university and at the manufacturing shops

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of the city. 2000 w. Am Mach—Vol. 30, No. 37. No. 86883.

Education of Mining Engineers. T. A. Rickard. Address delivered at the opening of the new Mining building of the University of California. 2500 w. Min & Sci Pr—Aug. 31, 1907. No. 86795.

Opening of the New Mining Building of the University of California. A report of the opening of the Hearst Memorial Building, with illustration. 2700 w. Min & Sci Pr—Aug. 31, 1907. No. 86793.

The National Engineering School of Mexico. Mansfield Merriman. Illustrates and describes the building and gives the history of this engineering college, undoubtedly the oldest institution for engineering instruction on the western continent. 3300 w. Eng News—Sept. 19, 1907. No. 87112.

Eight-Hour Day.

Probable Effect of an Eight-Hour Shift on Colliery Work. Gives tables showing the probable distribution of labor, estimated working costs, etc., at the Northumberland and Durham Collieries should the Eight Hours Bill be placed on the Statute Book. 1500 w. Ir & Coal Trds Rev—Aug. 23, 1907. No. 86744 A.

Exposition.

The Jamestown Exposition. C. A. Graves. An illustrated description of the exhibits relating particularly to mineral resources and mining. 4200 w. Mines & Min—Sept., 1907. No. 86770 C.

Gold Production.

Prosperity; Its Relation to the Increasing Production of Gold. Alex. Del Mar. An examination of the circumstances which denote prosperity or adversity and the effect of money circulation. 5000 w. Engineering Magazine — Oct., 1907. No. 87276 B.

Strikes.

Peace in Labor Affairs. Editorial discussion of the strike in the British shipbuilding trade. 2300 w. Engng—Aug. 23, 1907. No. 86731 A.

The Strike Situation in San Francisco. Henry K. Brent. Describes the conditions under which strike-breakers worked, discusses causes of the strike, etc. 5500 w. St Ry Jour—Sept. 21, 1907. No. 87171.

The Common Law on Strikes. A summary of court decisions on labor troubles, taken from the last report of the Commissioner of Labor. 2500 w. Ir Age—Sept. 26, 1907. No. 87230.

MARINE AND NAVAL ENGINEERING

Armor Plating.

The Development of Armored War Vessels. J. H. Morrison. The present article reviews the use of armor plating in the United States. Ills. 2800 w. Sci Am Sup—Aug. 31, 1907. Serial. 1st part. No. 86679.

Astronomy.

Navigation by Celestial Observation. Stephen P. M. Tasker. The present number shows how to locate one's self by day or night. 1500 w. Int Marine Engng—Oct., 1907. Serial. 1st part. No. 87198 C.

Boiler Cleaning.

Cleaning Marine Boilers. Lieut. H. C. Dinger. A general description of latest methods, especially those in use in naval service. 3500 w. Int Marine Engng—Oct., 1907. No. 87196 C.

Buoys.

Mooring-Buoy for the "Lusitania" and "Mauritania." Illustrates and describes the largest mooring-buoy that has ever been made. 500 w. Engng—Aug. 23, 1907. No. 86728 A.

Regarding Spar Buoys. C. H. Claudy. An illustrated article on the service and care of spar buoys. 1000 w. Sci Am—Sept. 21, 1907. No. 87123.

Coaling Vessel.

Self-Propelling Coaling Vessel. Illustrates, and briefly describes, a vessel for coaling steamships, with automatic self-registering weighing machine. 700 w. Sci Am Sup—Sept. 21, 1907. No. 87127.

Cruiser.

Scout Cruiser Salem. Illustrated description of the first cruiser to be launched in the United States equipped with Curtis turbines. 1400 w. Marine Rev—Sept. 12, 1907. No. 86899.

The American Scout Cruiser Salem. Illustrated detailed description of the vessel and its equipment. 1200 w. Int Marine Engng—Oct., 1907. No. 87197 C.

Electricity.

The Present Status of Electricity on Shipboard (Ueber den Heutigen Stand der Schiffselektrotechnik). C. Schulthes. Describes the various applications of electricity on shipboard, illustrating plants, distribution systems, etc. 2000 w. Serial. 1st part. Elektrotech Zeitschr—Aug. 1, 1907. No. 86989 D.

Fire Protection.

The Clayton Apparatus (Der Clayton Apparat). F. Heintzenberg. Illustrates and describes this system of fire-protec-

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tion on shipboard. The SO_2 generator and the method of installation and use. 3800 w. Serial. 1st part. Schiffbau—Aug. 28, 1907. No. 86956 D.

Historical.

A Century of Steamship Construction (Hundert Jahre Dampfschiffahrt). Conrad Matschoss. A review of steam navigation from Robert Fulton to the present day. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 17, 1907. No. 86983 D.

Lake Freighter.

Bulk Freighter William M. Mills. Illustrated description of one of the largest vessels on the lakes. 1000 w. Marine Rev—Sept. 5, 1907. No. 86825.

Lusitania.

The New Turbine Liner "Lusitania." Illustrations, with information of interest in regard to this and other fast vessels. 2000 w. Sci Am—Sept. 14, 1907. No. 86896.

Motor Boats.

The Kiel Motor Boat Exhibition (Die Kieler Motorboot-Ausstellung). A brief general description of the exhibits. 2000 w. Schiffbau—Aug. 14, 1907. No. 86-954 D.

Racing Boat.

New Racing Launch. Illustration, with description, of a racing launch of the torpedo boat type designed by André Gambin. 900 w. Engr, Lond—Sept. 6, 1907. No. 87086 A.

Salving Submarines.

A Study of Some Processes and Methods of Salving and Refloating Submarines (Etude de quelques Procédés et Méthodes de Sauvetage et de Renflouage des Navires Sous-Marines). M. Dibos. Considers the difficulties and dangers of submarine navigation, and the salving methods employed. 12000 w. Mem Soc Ing Civ de France—July, 1907. No. 86910 G.

Submarines.

Submarine Boat. Brief illustrated description of certain improvements in means of governing invented by John M. Gage. 600 w. Marine Rev—Sept. 5, 1907. No. 86824.

Survey Vessel.

Indian Survey Vessel "Palinurus." Illustrates and describes a steel single-screw steamer recently built for the Government of India, intended for marine survey work. 1000 w. Engng—Sept. 13, 1907. No. 87211 A.

Torpedo Boats.

German Torpedo Boat Construction. Information concerning these vessels, with illustration and brief description of the latest destroyer, fitted with turbines. 900 w. Engr, Lond—Sept. 13, 1907. No. 87218 A.

Train-Ferry.

Train-Ferry Steamer "Lucia Carbo" for the Entre Rios Railway. Illustrated description of a steamer designed to convey trains about 50 miles on the River Plate, South America. 500 w. Engng—Sept. 6, 1907. No. 87078 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Cadillac.

The 20 H. P. Cadillac Car. Illustrated description of a well-designed four-cylinder, vertical engined car. 1500 w. Autocar—Aug. 24, 1907. No. 86715 A.

Carbureters.

The Dentan Carbureter. Sections, with brief description of a novel carbureter. 1200 w. Auto Jour—Sept. 14, 1907. No. 87178 A.

Some Mysteries of the Carbureter. Charles B. Hayward. Explains causes of some of the troubles and means of correcting them. 3000 w. Automobile—Sept. 12, 1907. No. 86889.

Clutches.

The Friction Clutch in Automobile Practice. Forrest R. Jones. Discusses some of the undesirable properties in the types of clutches used. 2000 w. Automobile—Sept. 26, 1907. No. 87289.

Commercial Vehicles.

The Stoltz Steam Truck (Dampflastwagen Bauart Stoltz). Herr Pflug. Illustrates and describes the truck, engine, boiler, etc., and gives details of performance under various conditions. 2000 w. Verkehstech Woche u Eisenbahntech Zeitschr—Aug. 31, 1907. No. 86953 D.

Design.

Fundamental Principles in the Construction of Automobiles (Konstruktionsgrundlagen für den Bau von Kraftwagen). Ernst Valentin. Discusses materials of construction, transmission gears, etc., and illustrates various types of cars. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 24, 1907. No. 86986 D.

Ignition.

A Chapter on Magneto Ignition. Elmer G. Willyoung. Extract from Lecture No. 4, Correspondence School of Motor Car Practice. Explanatory. Ills. 1700 w. Automobile—Aug. 29, 1907. No. 86654.

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The Leitner Ignition and Lighting System for Motor Vehicles. Illustrates and describes a modification of the Leitner train-lighting system suitable for road motors of all kinds. 1000 w. Engng—Aug. 23, 1907. No. 86729 A.

Industrial Locomotives.

Gasoline Locomotives and Motor Cars. Illustrated descriptions of a gasoline locomotive, and a gasoline motor car recently built. 600 w. Eng News—Sept. 5, 1907. No. 86759.

Magneto.

A New Gearless Magneto. Illustrated describtion of the Van Raden gearless high tension magneto. 900 w. Autocar—Sept. 14, 1907. No. 87200 A.

Maja.

The Maja Car. Illustrates and describes a car produced by the German Daimler Company. 1000 w. Autocar—Sept. 14, 1907. No. 87202 A.

Mass.

The 18 H. P. and 24 H. P. Mass Cars. Illustrated description of cars gaining gold medals in the recent Scottish Reliability Trials. 1000 w. Autocar—Aug. 31, 1907. No. 86855 A.

Motobloc.

The Motobloc Petrol Cars. An illustrated description of these French-built cars. 2000 w. Auto Jour—Sept. 14, 1907. Serial. 1st part. No. 87177 A.

Peerless.

Peerless 1908 Presentation. Illustrated discussion of details of the new models. 1400 w. Automobile—Sept. 26, 1907. No. 87290.

Porthos.

The Six-Cylinder Porthos Car. Illustrated detailed description. 1200 w. Autocar—Sept. 14, 1907. No. 87201 A.

Reliability.

The Reliability of Motor Cars. Editorial on the value of the Scottish trials, and the performance of the cars. 2000 w. Engng—Sept. 26, 1907. No. 87079 A.

Speed.

The Effect of Weight Upon Speed. A report of tests made on the Brooklands track, showing the small difference made in the speed of a racing car by considerable variation in weight. 9000 w. Auto Jour—Sept. 7, 1907. No. 87050 A.

Springs.

Construction of Motor Vehicle Springs. J. G. Rumney. Read before the Soc. of Auto. Engrs. Calls attention to the methods which should be followed in the calculation of springs so as to guard against excessive deflection. 2500 w. Automobile—Aug. 29, 1907. No. 86652.

Stability.

A Formula Relative to a Condition of Stability of Automobiles and Especially of the Motor Omnibus (Formule Relative à une Condition de Stabilité des Automobiles et Spécialement des Autobus). Georges Marié. A theoretical and mathematical discussion of the conditions which have to be fulfilled to prevent skidding, overturning, etc. Ills. 12000 w. Mem Soc Ing Civ de France—June, 1907. No. 86908 G.

Steering.

A Criticism of Steering Gears in General Use. Louis T. Weiss. A criticism of the action of the connecting rod with suggestion of a way to prevent the dropping of the rod if the springs should break. 800 w. Automobile—Sept. 26, 1907. No. 87291.

Westinghouse.

The Westinghouse Petrol Cars. Illustrates and describes the leading features of these cars, and also some of the minor details. 2500 w. Auto Jour—Sept. 7, 1907. No. 87049 A.

Wind Resistance.

Wind Resistance. Douglas Leechman. Discusses some effects of wind pressure, the importance of form, and related subjects, as applied to motor vehicles. 3000 w. Auto Jour—Aug. 24, 1907. No. 86713 A.

Wind Screens.

The Effect of Wind-Screens on Speed. An illustrated account of experiments on the Brooklands race track. 2000 w. Auto Jour—Aug. 24, 1907. No. 86714 A.

COMBUSTION MOTORS.

Alcohol.

Alcohol for Operating Engines. Gives a synopsis of an interesting report prepared by Charles E. Lucke and S. M. Woodward, on official tests of internal combustion engines on alcohol fuel. 4500 w. Ir Age—Sept. 26, 1907. No. 87231.

Tests of Internal-Combustion Engines on Alcohol Fuel. Charles Edward Lucke and S. M. Woodward. A report of researches made to determine whether the gasoline and kerosene engines at present on the American market can run on alcohol as fuel; and what improvements might be desirable in the design of engines manufactured especially for alcohol. Ills. 31200 w. U S Dept of Agri, Bul. 191—Sept. 14, 1907. No. 87285 N.

Does Alcohol Attack Metallic Surfaces? G. Lessard. Trans. from *La Vie Automobile*. An examination of the effect of alcohol, and the effect of impurities contained in it. 1200 w. Automobile—Aug. 29, 1907. No. 86653.

Gas Analysis.

Rapid and Accurate Gas Analysis. Edwin Barnhart. Illustrates and describes an apparatus giving a high degree of accuracy, and a minimum of time. A complete analysis of coal or producer gas re-

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quires about twenty minutes. 1200 w. Elec-Chem & Met Ind—Sept., 1907. No. 86835 C.

Gas Cleaning.

Gas Engines. Informal discussion of what is the best apparatus and most economical system for cleaning producer or furnace gas to be used in gas engines; and to what extent ordinary producer gas is used in gas engines, and the results obtained by removing tar or soot. 3500 w. Pro Am Soc of Civ Engrs—Aug., 1907. No. 86646 E.

Gas Engines.

Gas Engine Breakdowns. Michael Longridge. From the annual report to the British Engine and Boiler Insurance Company. 5000 w. Mech Engr—Aug. 31, 1907. No. 86858 A.

Pressures and Work in a Gas Engine. Cecil P. Poole. Gives formulæ for pressures developed by compression, combustion, and expansion; work, horse-power, and mean effective pressure. 2000 w. Power—Sept., 1907. No. 86676 C.

Novelties in Large Gas Engines (Neuerungen an Grossgasmaschinen). Herr v. Hansdorff. Relates principally to the two-cycle Körting engines produced by Pokorny and Wittekind of Frankfurt. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 17, 1907. No. 86985 D.

Gas Power Plants.

Mains and Fittings for Gas-power Plants. L. L. Brewer. Considers the proper design of mains, special fittings, and related subjects. 2000 w. Power—Sept., 1907. No. 86670 C.

The Modern Gas Engine Power Plant (Die Moderne Gasmaschinenzentrale). M. Langer. Discusses the fundamental considerations in the design of a gas-engine power plant, with particular reference to plants for the utilization of the waste gases in ironworks. 5000 w. Stahl u Eisen—Aug. 14, 1907. No. 86933 D.

Gas Producers.

Gas Generation and the Development of Producer Plants (Ueber Gaserzeugung und die Entwicklung der Generatorgasanlagen). J. Schmidt. A history of the generation of gas for lighting and power purposes from 1867 to the present time. Ills. 2500 w. Serial. 1st part. Elektrotech u Polytech Rundschau—Aug. 14, 1907. No. 86964 D.

Indicator Diagrams.

Indicator Diagrams from a Canadian Crude-oil Engine. H. Addison Johnston. Briefly describes the Johnston crude-oil engine and examines indicator diagrams taken. 900 w. Power—Sept., 1907. No. 86669 C.

Oil Engines.

Novel High Compression Oil Engine. Alfred Gradenwitz. An illustrated detailed description of the Trinkler motor. 1000 w. Mach, N Y—Sept., 1907. No. 86748 C.

The De La Vergne Oil Engine. Illustrated description of a new engine claiming absolute safety, reliability, economy, high speed, small space and light weight. 1500 w. Ir Age—Sept. 26, 1907. No. 87228.

See also Electrical Engineering, Generating Stations.

Water Gas.

Water Gas (Ueber Wassergas). H. Dicke. Describes the Dellwik-Fleischer system of water-gas generation, the first part of the serial describing the generator and giving details of operation, efficiency, losses, and costs. Curves. Ills. 3000 w. Serial. 1st part. Stahl u Eisen—Aug. 14, 1907. No. 86932 D.

HEATING AND COOLING.

Auditorium.

Cooling an Auditorium by the Use of Ice. John J. Harris. Describes means used to cool the auditorium of the Scranton High School during commencement exercises. 500 w. Heat & Vent Mag—Sept., 1907. No. 87189.

Factories.

The Ventilation of Factories. Editorial review of the Departmental Committee report to the Home Secretary, on investigations made to remove injurious dust in the trades. 2500 w. Engng—Aug. 23, 1905. No. 86732 A.

Furnace.

Fan Furnace System of Heating a Hospital. Drawings and description of an example of the use of a fan with a warm air furnace. 1200 w. Met Work—Sept. 7, 1907. No. 86826.

Heat Losses.

Methods of Estimating Heat Losses from Buildings. Charles L. Hubbard. Presents, in tabular form, the information contained in Reginald Pelham Bolton's heat loss chart, with figures of several additional forms of construction. 1200 w. Heat & Vent Mag—Sept., 1907. No. 87188.

History.

Heating from Roman Times to 1870. Hermann Vetter. Translation of a paper appearing in *Gesundheits-Ingenieur*. 2800 w. Met Work—Sept. 28, 1907. Serial. 1st part. No. 87274.

Hot Water.

The Reck System of Heating by Hot-Water Circulation (Die Warmwasserheizung "System Reck" mit Wassermischung). An illustrated description of the system and of recent installations. 4500 w. Gesundheits Ing—Aug. 24, 1907. No. 86977 D.

Houses.

The Heating of Houses in France.

Charles F. Hauss. Describes the hot-water system as applied to an apartment house, and to a dwelling house. Plans. 2500 w. Met Work—Sept. 14, 1907. No. 86893.

Refrigeration.

Refrigerating Plant of Washington Brewing Company. Illustrates and describes a modern plant in Columbus, Ohio, designed for economical operation. 2500 w. Engr, U S A—Sept. 16, 1907. No. 87046 C.

The Cooling Plant for Walter Baker & Co., Ltd., Dorchester, Mass. Describes a plant embodying advanced ideas in refrigerating engineering. Ills. 2000 w. Eng Rec—Sept. 21, 1907. No. 87155.

Shops.

The Heating and Ventilation of Machine Shops. Charles L. Hubbard. Discusses methods of air distribution, showing the application of hot-blast heating to machine shops and other buildings of similar construction. 2500 w. Mach, N Y—Sept., 1907. No. 86747 C.

Vacuum System.

The Vacuum Heating System in the Godfrey Block, Grand Rapids. Brief description, with plans, of a departure from the usual arrangement of connections and radiation for vacuum heating. 1600 w. Eng Rec—Sept. 14, 1907. No. 87032.

HYDRAULICS.

See also Civil Engineering, Water Supply.

Centrifugal Pumps.

Even Diffusers on Centrifugal Pumps (Glatter Diffuser bei Zentrifugalpumpen). J. Novak. A theoretical and mathematical discussion of their design. Ills. 2500 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 30, 1907. No. 86979 D.

Contraction.

On the Free Discharge of Liquids from Orifices with Defective Contraction (Ueber den Freien Ausfluss von Flüssigkeiten an Mündungen bei Unvollkommener Kontraktion). A. Jarolimek. Considers the three cases of a circular opening, a long narrow slit, and an annular orifice. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—Aug. 9, 1907. No. 86972 D.

Friction.

The Friction of Moving Liquids (Sugli Attriti dei Liquidi in Movimento). Pietro Alibrandi. A mathematical and historical treatment of the subject, reviewing various investigations. 10000 w. Serial. 1st part. Ann della Societá d Ing e d Arch Ital—Aug. 1, 1907. No. 86903 F.

Pipe Velocity.

The Velocity of Water in Conduits. From *Zeit. des Ver. Deut. Ing.* Describes the installation of J. M. Voith, of Heidenheim for conducting turbine tests, and the methods. 1200 w. Engng—Aug. 23, 1907. No. 86733 A.

Pumping Plants.

Mechanical Tests of Pumping Plants Used for Irrigation. R. P. Teele. A comparison of gasoline and steam outfits and of centrifugal, reciprocating, and air lift pumps. 1500 w. Engr, U S A—Sept. 2, 1907. No. 86709 C.

Pumping Plant for the New South Dock, Cardiff. An illustrated detailed account of the machinery of a plant constructed to deal with an unusually large quantity of water. 1300 w. Engng—Sept. 6, 1907. No. 87077 A.

Turbine Governing.

Notes on the Governing of Hydraulic Turbines. Robert S. Ball. Read before the British Assn. A discussion of details of governing mechanisms for hydraulic turbines. Ills. 4000 w. Engng—Aug. 23, 1907. No. 86737 A.

Mechanical Details of the Governors of the Water-Wheel Equipment of the Kern River Plant No. 1. Arnold Pfau. Describes the generators and the exciter units, explaining the method of regulation. Ills. 2200 w. Am Mach—Vol. 30, No. 38. No. 87105.

MACHINE WORKS AND FOUNDRIES.

Automobile Works.

The New Manufacturing Plant of the George N. Pierce Co., Buffalo, N. Y. Howard S. Knowlton. An illustrated description of this new automobile manufacturing establishment, built on the site of the Pan-American Exposition grounds. 48000 w. Eng Rec—Sept. 7, 1907. No. 86789.

Bevel Gears.

A French Machine for Cutting Bevel Gears. G. Eude. Trans. from *Revue de Mécanique*. Illustrated description of a machine for cutting bevel gears at a single cut. 2000 w. Am Mach—Vol. 30, No. 36. No. 86810.

Brass Waste.

Brass Waste in Machine Shop and Foundry. Walter J. May. Briefly considers mechanical wastes which affect the costs of shops and foundries. 1200 w. Prac Engr—Sept. 13, 1907. No. 87203 A.

Cupolas.

A Continuous Cupola Tuyere System. Illustrated description of a cupola equipped with Knoeppel tuyeres, which are designed to introduce a large volume of air into the furnace at a low pressure, insuring a low melting point, and uniform operating conditions. 1000 w. Ir Trd Rev—Sept. 5, 1907. No. 86776.

Cutlery Works.

Manufacture of Cutlery at Solingen. Report by C. F. Johnston on the industrial methods adopted at Solingen, Ger-

many, giving details on sanitation and conditions of labor. 3000 w. Mech Engr —Aug. 24, 1907. No. 86719 A.

Cutting Metals.

Cutting Metals by Oxygen (Le Coupage des Métaux par l'Oxygène). L. Guillet. A method of cutting large masses of metal is described, which consists of heating along the cutting line to a welding heat with a blowpipe and following the latter with a jet of pure oxygen which forms a very fusible oxide. Ills. 2000 w. Génie Civil—Aug. 10, 1907. No. 86925 D.

The Cutting of Iron and Steel by Means of Oxygen (Das Zerschneiden von Eisen- und Stahlmassen mittels Sauerstoff). Arthur Dohmen. Describes the system of cutting iron and steel by a blowpipe and a jet of oxygen and illustrates many examples of the use which may be made of the system. 2200 w. Schiffbau—Aug. 28, 1907. No. 86957 D.

Dust Prevention.

Improved Methods of Dust Prevention in the Grinding Trades. Samuel R. Bennett. Describes apparatus, explaining the principles for a wet method of "racing" grindstones when first hung, and an improved hood for catching dust, etc., in the processes of dry grinding. Ills. 2200 w. Jour Soc of Arts—Aug. 30, 1907. No. 86849 A.

Engine Works.

The Minneapolis Steel and Machinery Co. Illustrated description of a factory for the manufacture of Corliss and gas engines. 2800 w. Ir Trd Rev—Sept. 5, 1907. No. 86773.

Electric Ovens.

Electrically Heated Re-heating and Tempering Furnaces (Der Glüh- und Härteofen mit Elektrisch Geheiztem Schmelzbad). L. M. Cohn. A paper dealing principally with small furnaces, read before the Elektrotechnische Verein in Vienna. Ills. 2800 w. Serial. 1st part. Elektrotech u Maschinenbau—Aug. 18, 1907. No. 86967 D.

File Works.

Making Swiss Files in America. An illustrated description of the plant and methods of manufacture of the American Swiss File & Tool Co., Elizabethport, N. J. 3000 w. Mach, N Y—Sept., 1907. Serial. 1st part. No. 86750 C.

Fire Protection.

The Prevention of Fires in Industrial Establishments (La Prevenzione degli Incendi negli Stabilimenti Industriali). A description of the fire-protection arrangements and apparatus of a Milan firm, which are a model of completeness and efficiency. 3500 w. Elettricità—Aug. 30, 1907. No. 86902 D.

Flanged Fittings.

Patterns for Flanged Pipe Fittings. F. W. Barrows. Explains how patterns and core boxes are designed, made, combined and recorded for standard and extra heavy flanged pipe fittings. Ills. 6500 w. Am Mach—Vol. 30, No. 38. No. 87107.

Forging.

Forging a Lathe Boring Tool. J. F. Sallows. Directions, with diagrams. 500 w. Mach, N Y—Sept., 1907. No. 86752 C.

Foundries.

Some New Steel Foundries. Illustrates and describes plant and methods used at different foundries in England, United States and Germany. 4500 w. Ir & Coal Trds Rev—Aug. 23, 1907. No. 86743 A.

Iron Foundry of the Hill Clutch Co. Illustrated description of a gray iron plant in Cleveland, O., designed for the production of power transmission machinery castings. 1500 w. Foundry—Sept., 1907. No. 86818.

The Foundry Using Moulding Machines of the Aplerbecker Ironworks, Brügmann, Weyland and Co. in Aplerbeck (Die Giesserei für Formmaschinenbetrieb der Aplerbecker Hütte, Brügmann, Weyland and Co. in Aplerbeck). An illustrated description of this foundry in which all moulding is done by machines. 2500 w. Stahl u Eisen—Aug. 7, 1907. No. 86931 D.

Malleable Cast Iron Foundries (Einiges über Tempergiessereien). W. Müller. Discusses the production of malleable cast iron in crucible, cupola, converter and reverberatory furnaces. Ills. 3200 w. Stahl u Eisen—Aug. 28, 1907. No. 86934 D.

Furnaces.

Side-Fired Furnaces for Annealing, etc. Walter J. May. Illustrates and describes various types of side-fired furnaces and annealing ovens. 1000 w. Prac Engr—Aug. 30, 1907. No. 86856 A.

Gauges.

A New Swedish Combination Gaging System. E. A. Dixie. An illustrated account of a new system of gauging and of originating shop sizes. 1800 w. Am Mach—Vol. 30, No. 38. No. 87104.

Screw Gauges. Extracts from the Engineering Standards Committee's report on British Standard Systems for limit gauges for screw threads, with editorial. 1800 w. Engr, Lond—Sept. 13, 1907. No. 87220 A.

Gear Changing.

A Four Speed Change-Gear Device. B. F. Landis. Illustrates and describes an arrangement, limited to four speeds, which has proved to be efficient. 1200 w. Am Mach—Vol. 30, No. 39. No. 87241.

Gears.

Machine-molded Teeth on Large Cast Gears. An illustrated article showing how the teeth of gears are machine-

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molded from a simple tooth block, and some large herring-bone gears. 2500 w. Am Mach—Vol. 30, No. 37. No. 86884.

Grinding.

Grinding Cutters for Rotary Planers. John Riddell. A wood grinding machine which automatically grinds every tooth alike and gives them all the correct clearance is illustrated and described. 700 w. Am Mach—Vol. 30, No. 39. No. 87242.

Jigs.

A Milling Jig for Connecting-rods and Straps. Grover Roy. Describes the construction and use of a convenient jig. Ills. 900 w. Am Mach—Vol. 30, No. 38. No. 87111.

Lapping.

Lapping. E. A. Johnson. Describes methods used in lapping metals. Ills. 1700 w. Am Mach—Vol. 30, No. 37. No. 86886.

Lathe.

The Lo-swing Lathe and Some of Its Work. Illustrated description of a lathe and its work as used in a Newark, N. J., shop. 1000 w. Am Mach—Vol. 30, No. 36. No. 86811.

Metallography.

Metallography in Practice (Metallographie en Practijk). P. D. C. Kley. An illustrated discussion of several of the industrial applications of metallography. 6000 w. De Ingenieur—Aug. 24, 1907. No. 86993 D.

Milling.

A New Milling Machine Dividing Head. Illustrated description of the Becker-Brainard universal index and spiral head. 1200 w. Ir Age—Sept. 5, 1907. No. 86745.

Milling Attachments for the Lathe. Oscar E. Perrigo. Illustrates and describes attachments by means of which many jobs usually performed on a milling machine may be done on the lathe. 1500 w. Am Mach—Vol. 30, No. 38. No. 87110.

Modern Machinery.

Modern Machinery and Its Future Development. H. L. Brackenbury. Read before the British Assn. An account of the forces which have affected the development. Remarks are limited to small machinery, covering the same ground as the engine lathe. 4000 w. Engng—Aug. 30, 1907. No. 86873 A.

Molding.

An Air Cooled Gas Engine Cylinder. E. F. Lake. Methods of molding and pattern-making for light weight automobile castings. Ills. 3500 w. Foundry—Sept., 1907. No. 86816.

Oerlikon.

The Oerlikon Works. A brief illustrated description of one of the most important factories in Switzerland. 1000 w. Engr, Lond—Aug. 23, 1907. No. 86741 A.

Pattern Shops.

Electric Power in a Pattern Shop. A. B. Homo. Indicates some of the points of superiority as experienced by the writer. 1100 w. Am Mach—Vol. 30, No. 38. No. 87106.

Pipe Machinery.

Some New Stoever Pipe Machinery. Illustrates and describes a pipe threading and a pipe bending machine recently brought out. 2000 w. Ir Trd Rev—Sept. 5, 1907. No. 86775.

Press Tools.

Tools for Making Can Tops. W. H. Sirius. Illustrates and describes an interesting combination of press tools. 2000 w. Am Mach—Vol. 30, No. 38. No. 87108.

Propellers.

Laying Out a Propeller. J. S. Watts. Describes a method of making a working drawing of a propeller. Diagram. 800 w. Mach, N Y—Sept., 1907. No. 86751 C.

Records.

A System for Caring for Changes in Machine Parts. E. R. Vator. Describes a process of recording drawings and changes and method of locating a piece used. 1200 w. Am Mach—Vol. 30, No. 37. No. 86885.

Riveting.

How to Drive Steel Rivets by Hand. Henry Mellon. Considers driving up the furnaces of a two-furnace marine boiler the plates of which are ⅜ inch thick. 800 w. Boiler Maker—Sept., 1907. No. 86667.

Safety Appliances.

Safety Appliances on Drawing-Frames in Cotton-Mills. Describes the details of the drawing process, showing the points where risk is entailed, and the methods of guarding against these risks. Ills. 1700 w. Engng—Aug. 30, 1907. No. 86869 A.

Screw Machines.

The Camming of Automatic Screw Machines. C. L. Goodrich and F. A. Stanley. Illustrates and describes the method of determining cam angles of Pratt & Whitney automatics by calculation or graphically to give desired feeds per turn of spindle. 3800 w. Am Mach—Vol. 30, No. 37. Serial. 1st part. No. 86882.

Solders.

Tests of Solders (Ueber Versuche mit Lötmitteln). Adolf Lippmann. Discusses a large number of types of solders and describes the results of tests made upon them. Ills. 3500 w. Serial. 1st part. Elektrotech Zeitschr—Aug. 29, 1907. No. 86992 D.

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Speeds.

Speeds and Feeds in Geometric Progression. John Parker. Explains how speeds and feeds for machine tools are calculated in geometric progression by logarithms and shows typical examples. 2000 w. Am Mach—Vol. 30, No. 39. No. 87237.

Threads.

Repairing Defective Threads. D. S. Cole. Describes briefly a method of repairing by adding the necessary new stock in the form of a wire soldered in a groove. 800 w. Am Mach—Vol. 30, No. 39. No. 87238.

A Compensating Thread-cutting Device. Ethan Viall. Illustrated description of the device and its use. 700 w. Am Mach—Vol. 30, No. 39. No. 87240.

Tool Works.

The Canada Tool Works. H. R. Cobleigh. An illustrated detailed description of the enlarged plant of the John Bertram & Sons Company at Dundas, Ontario. 3800 w. Ir Age—Sept. 12, 1907. No. 86879.

Twist Drills.

The Making and Testing of Twist Drills. Fred H. Colvin. Illustrates and describes some of the tools used, methods of testing and results obtained. 5000 w. Am Mach—Vol. 30, No. 39. No. 87239.

Welding.

The Oxy-Acetylene Blowpipe. Cecil Lightfoot. From a paper presented to the Int. Acetylene Assn. Deals with the types of blowpipe in use and their practical application. 1600 w. Ir Age—Sept. 19, 1907. No. 87102.

Worm Gearing.

Hobs for Worm Gears. John Edgar. Suggestions on the design and proportions of the hob. 1500 w. Mach, N Y—Sept., 1907. No. 86754 C.

MATERIALS OF CONSTRUCTION.

Alloy Investigations.

The Thermic Method of Analysis of Professor Tammann and the Researches on the Constitution of Alloys at the University of Göttingen (La Méthode d'Analyse Thermique du Professeur Tammann et les Recherches sur la Constitution des Alliages de l'Université de Goettingen). A. Portevin. Ills. 6000 w. Rev d Métal—Aug., 1907. No. 86916 E + F.

Alloy Steels.

Nickel Steel. E. F. Lake. Gives much information in regard to the effect of nickel, the treatment, and applications. 2500 w. Mach, N Y—Sept., 1907. No. 86753 C.

Boron Steels (Les Aciers au Bore). L. Guillet. Describes the influence of boron on the metallographic and physical properties of normal, tempered, annealed and case-hardened steels. Ills. 5000 w. Rev d Métal—Aug., 1907. No. 86915 E + F.

Recent Researches on Ternary and Quarternary Vanadium Steels (Nouvelles Recherches sur les Aciers au Vanadium Ternaires et Quarternaires). L. Guillet. Describes the results of tests to determine the effects of different quantities of vanadium on the properties of the alloys. 4000 w. Rev d Métal—Aug., 1907. No. 86914 E + F.

Bearing Metals.

Bearing Metal for Automobile Use. Thomas J. Fay. Extract from a book on Materials for Automobile Construction. 4500 w. Automobile—Sept. 19, 1907. No. 87118.

Bronze.

Structural Bronze for Automobile Parts. Thomas J. Fay. Extracts from "Materials for Automobile Construction." Gives tests of this material showing its strength, with information concerning its production. 3000 w. Automobile—Sept. 5, 1907. No. 86823.

Ferro-Alloys.

Ferro-Alloys for Foundry Use. E. Houghton. Discusses methods of treatment to secure definite chemical and physical properties in iron, giving analyses of various alloys. 4000 w. Foundry—Sept., 1907. No. 86819.

Magnetic Alloys.

On the Magnetic Properties of Heusler's Alloys. J. C. McLennan. Abstracted from the *Phys. Rev.* A report of investigations made of these alloys. 1000 w. Elect'n, Lond—Sept. 6, 1907. No. 87067 A.

Rods.

The Effect of Antimony on High-Brass Rods. Erwin S. Sperry. Shows that over .02 per cent. of antimony in high brass will cause it to crack in rolling, and demonstrates that there is still a lack of uniformity in cathode copper. 900 w. Brass Wld—Sept., 1907. No. 87186.

Test Bars.

Tests of Some Brass and Bronze Bars. Harry B. de Pont. Gives results of a series of experiments to ascertain their chemical and physical properties. 1700 w. Foundry—Sept., 1907. No. 86817.

Thermit Steel.

Thermit Steel. Gustav Reiniger. A report of tests made with the object of deciding on the possibility of producing thermit steel of the same strength as the hard steels at present produced. Ills. 4000 w. Jour U. S. Art—July, 1907. No. 87094 D.

Tungsten.

Tungsten and Its Use as a Hardener of Steel. J. Forrest Lewis. Gives figures

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regarding the increasing production of ores of this metal and its use in the manufacture of "high-speed" steel. 2000 w. Ores & Metals—Sept. 5, 1907. No. 86814.

MEASUREMENT.

Accuracy.

On Accuracy in Mensuration and Calculation. Defines accuracy as distinct from sensitiveness, and discusses the advantage of expressing approximate results in measuring in few figures. 4500 w. Engr, Lond—Sept. 6, 1907. No. 87084 A.

Belts.

The Determination of Length of Belts and Diameters of Cone Pulleys. Mathematical. 400 w. Prac Engr—Sept. 6, 1907. No. 87051 A.

Cylinders.

Test of Tube-Connected Cylinders. S. F. Jeter. Gives a cylinder head designed by the writer and results of a series of comparative tests made between that form and the regular bumped head. Ills. 700 w. Power—Sept., 1907. No. 86674 C.

Graphite Analysis.

A Convenient Means of Determining the Ash in Graphite. S. S. Sadtler. Describes the method used. 700 w. Jour Fr Inst—Sept., 1907. No. 87088 D.

Indicator.

Toolmakers' Universal Test Indicator. J. D. Stryker. Illustrated description. 600 w. Am Mach—Vol. 30, No. 38. No. 87109.

Pressure-Gauges.

The Accuracy of Pressure-Gauges. An account of tests made at the National Physical Laboratory in England. 1500 w. Engng—Aug. 23, 1907. No. 86734 A.

Pyrometry.

Optical Pyrometry. Dr. L. Holborn. Read before the British Assn. Discusses the method of measuring high temperatures based on the distribution of energy in the spectrum, and the increase of energy between the wave-lengths as the temperature rises. 4000 w. Engng—Sept. 6, 1907. No. 87081 A.

High Temperature Measurements. Thomas C. McKay. Indicates the industrial applications of electrical and radiation thermometers, describing types. 1500 w. Cal Jour of Tech—Aug., 1907. No. 87096.

Regulations.

Weights and Measures Regulations. Information concerning the new regulations of the British Board of Trade, which come into force Oct. 1. 1907. 2500 w. Ir & Coal Trds Rev—Sept. 13, 1907. No. 87183 A.

Testing Methods.

Modern Methods of Mechanical Testing of Metallurgical Products (Les Méthodes Modernes d'Essais Mécaniques des Produits Métallurgiques). L. Guillet. A description of the evolution of testing methods, the most modern developments, and the conclusions which may be drawn from them, beginning with tension tests. Ills. 8000 w. Serial. 1st part. Rev Gen d Sci—Aug. 15, 1907. No. 86919 D.

Weighing Machine.

Machine for Weighing the Forces on a Cutting Tool. John F. Brooks. Read before the British Assn. Illustrated desciption of an apparatus for measuring the three component forces which result in the formation and separation of a chip of metal in a lathe, explaining the principle of its operation. 900 w. Engng—Aug. 23, 1907. No. 86730 A.

POWER AND TRANSMISSION.

Air Compressors.

A Month's Output of Air Compressors. Frank Richards. Gives information showing the rapid growth of air-power and the many applications. 1700 w. Compressed Air—Sept., 1907. No. 86710.

Reciprocating Air-Compressors. W. Reavell. Deals with the features which are necessary to obtain high efficiency. 1200 w. Compressed Air—Sept., 1907. No. 86711.

Barge Crane.

A 60-Ton Barge Crane of Variable Range (Ponton-Bigue de 60 Tonnes, à Portée Variable). Ch. Dantin. Illustrated description of a crane in use on the Suez Canal. 2000 w. Génie Civil—Aug. 31, 1907. No. 86928 D.

Belts.

Pull of Belts. V. C. Wynne. Discusses tension of belts, sag, weight, and methods of maintaining tension. 1500 w. Engr, U S A—Sept. 16, 1907. No. 87047 C.

Compressed Air.

Compressed Air and the Kinetic Theory of Gases. J. H. Hart. Shows how this theory makes clear obscure points. 2000 w. Power—Oct., 1907. No. 87268 C.

Cranes.

Electric Cranes. H. H. Boughton. Reviews the rapid development of electric cranes, stating their advantages, giving particulars of comparative tests of electric and hydraulic cranes. 3800 w. Elect'n, Lond—Sept. 6, 1907. Serial. 1st part. No. 87062 A.

The Design of Under-Carriages for Jib Cranes. E. G. Fiegehen. The present article considers types of under-carriages, axles, and gearing. Ills. 2000 w. Prac Engr—Aug. 23, 1907. Serial. 1st part. No. 86716 A.

Dock Cranes.

Modern Dock and Harbor Cranes (Moderne Werft- und Hafenkrane). Bruno Müller. An illustrated description of the

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dock cranes exhibited at the Milan Exposition by the firm of Bechem and Keetman, Duisburg. 2000 w. Schiffbau—Aug. 14, 1907. No. 86955 D.

Electric Driving.

The Electric Driving of Ring Spinning Machines. Enrico Bignami. An account of tests made by Messrs. Brown, Boveri & Co. and the results. Ills. 1500 w. Elec Rev, Lond—Aug. 23, 1907. No. 86720 A.

Electricity for Cement Plants. J. B. Porter. Read before the Assn. of Am. Portland Cement Mfrs. Points out some of the special advantages of the electric drive in the manufacture of cement, both in economy and flexibility. 2500 w. Eng Rec—Sept. 21, 1907. No. 87152.

Elevators.

A Positively Controlled, High-Speed Electric Elevator. Illustrates and describes a mechanism developed by Charles Richardson Pratt. 1200 w. Eng News—Sept. 26, 1907. No. 87251.

Notes on Elevators. E. R. Carichoff. Discusses both hydraulic and electric elevators, their safety, economy, efficiency, etc. 2500 w. Elec Rev, N Y—Sept. 21, 1907. No. 87158.

The Electric Elevator Equipment for a Tall Office Building. Illustrates and describes an installation to meet unusual conditions in an 18-story building at No. 1 Wall St., New York City. 1500 w. Eng Rec—Sept. 21, 1907. No. 87150.

Failures.

Failures of Power-Generating Plant. Editorial review of the report of Michael Longridge, for 1906, on the casualties of steam engines, gas and oil engines, and electrical machinery. 2000 w. Engng—Aug. 30, 1907. No. 86871 A.

Lifting Magnets.

A New Line of Lifting Magnets for Use with Cranes. Illustrated description of new designs to meet requirements. 900 w. Eng News—Sept. 26, 1907. No. 87248.

Power Plants.

Test of Power Plant of Home Gas Company, Redlands, California. W. F. Durand. An illustrated description of the plant, with a discussion of the acceptance test made by the writer. 3500 w. Engr, U S A—Sept. 2, 1907. No. 86707 C.

The Power Plant of the Elgin National Watch Works. An illustrated description of a new power plant to supply a group of factory buildings. 3000 w. Eng Rec—Sept. 14, 1907. No. 87028.

Turbo-Compressors.

High-Pressure Centrifugal Blowers (Ventilateurs Centrifuges à Haute Pression). A. Rateau. Illustrates and describes various types of turbo-compressor, comparing them with piston machines, and discussing their advantages. 10000 w. Rev d Métal—Aug., 1907. No. 86913 E + F.

High-Pressure Centrifugal Blowers (Kreiselgebläse für Hohen Druck). A. Rateau. An illustrated description of their development and of various types and installations. 7000 w. Zeitschr d Ver Deutscher Ing—Aug. 17, 1907. No. 86984 D.

STEAM ENGINEERING.

Boiler Cleaning.

See Marine and Naval Engineering.

Boiler Explosions.

Three Notable Boiler Explosions. Illustrated account of the explosion on the steamer "City of Trenton"; the explosion that destroyed a power plant at Marion, Ohio; and the explosion at the St. Joseph's Orphan Asylum, Philadelphia. 1000 w. Locomotive—July, 1907. No. 87093.

Boilers.

An English Boiler Improvement. Illustrates and describes the Temperley-Cockburn system of steam extraction and progressive heating in water-tube boilers. 2300 w. Ir Age—Sept. 19, 1907. No. 87101.

Cooling Towers.

The Capacity of Cooling Towers. Reviews a paper by C. O. Schmitt, read before the S. African Assn. of Engrs. on "Cooling Towers for the Circulation Water of Surface Condensing Plants." Deals with four types of towers, discussing their efficiency. Ills. 2000 w. Engr, Lond—Sept. 13, 1907. No. 87221 A.

Engine Breakdowns.

Engine Breakdowns and Their Lessons. Michael Longridge. Information of interest from the annual report for 1906, in regard to the safe working of power plants. Ills. 7000 w. Mech Engr—Aug. 24, 1907. No. 86717 A.

Engine Foundations.

Steam-engine Foundations. R. T. Strohm. Considers the requirements, loads suited to various soils, kind of material to be used, and things to guard against. 2000 w. Power—Oct., 1907. No. 87271 C.

Fuels.

Burning Cheap Grades of Fuel. Kingsley Williams. Points on the firing with anthracite dust and soft coal. 700 w. Elec Wld—Sept. 7, 1907. No. 86847.

The Choice of a Bituminous Coal. R. H. Kuss. Discusses the problem of selecting coal, considering the availability, cost, adaptability, smoke, refuse, and treatment. 2500 w. Eng Rec—Aug. 31, 1907. No. 86694.

Steam Production from the Cheaper

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Grades of Anthracite. William D. Ennis. An illustrated discussion of methods of burning the small and cheap grades, giving much information in regard to low-grade fuels. 2700 w. Engineering Magazine—Oct., 1907. Serial. 1st part. No. 87282 B.

Fuel Specifications.

The Purchase of Coal Under Specifications. J. E. Woodwell. Presented at meeting of Am. Soc. for Test. Mat. Considers methods of sampling and analysis, variations in heating values, etc. 6000 w. Mines & Min—Sept., 1907. No. 86771 C.

Fuel Testing.

The Fuel-Testing Plant of the Geological Survey. C. T. Wilkinson. Illustrations and particulars of the plant in Virginia. 800 w. Eng & Min Jour—Sept. 21, 1907. No. 87167.

The Swiss Government Fuel-Testing Establishment in Zürich (Die Eidgenössische Prüfungsanstalt für Brennstoffe in Zürich). Heinrich Trachsler. Describes in detail the various parts of the establishment and the apparatus installed. Ills. 4000 w. Schweiz Bau—Aug. 24, 1907. No. 86959 D.

Furnace Lining.

The Lining of Steam Boiler Furnaces. William Kavanagh. Suggestions of importance in securing economical operation of the plant. 1000 w. Elec Wld—Sept. 7, 1907. No. 86848.

Gas Analysis.

Flue-gas Analysis: Its Value. Joseph W. Hays. Discusses its importance in determining furnace efficiency. 2000 w. Power—Oct., 1907. No. 87267 C.

Governor.

Some Peculiarities of the Rites Governor. S. H. Bunnell. Discusses some peculiarities in the action of this governor, the causes and prevention. 1500 w. Engr, U S A—Sept. 2, 1907. No. 86708 C.

Indicators.

Indicator Practice. Arthur Curtis Scott. Illustrates and describes types of indicators and reducing gears, methods of taking diagrams, and of combining diagrams. 3500 w. Engr, U S A—Sept. 16, 1907. No. 87048 C.

Indicators (Neuerungen an Indikatoren). A. Wagener. Illustrates and describes several newly-developed devices and gives a technical discussion of their use. 7500 w. Zeitschr d Ver Deutscher Ing—Aug. 31, 1907. No. 86987 D.

Lubrication.

The Design of Ring Lubricating Devices (Die Bearbeitung der Ringschmierlager). C. Volk. Illustrated description of various types. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 10, 1907. No. 86982 D.

Oil Fuel.

Technical Aspects of Oil as Fuel. Franz Erich Junge. Discusses liquid fuels, their treatment and the formation of combustible mixtures, with regard to their application in power plants. 3000 w. Power—Oct., 1907. Serial. 1st part. No. 87266 C.

Pumps.

Pump Troubles and Their Remedies. H. Jahnke. Discusses some probable causes of steam pump troubles and their correction. 1800 w. Power—Oct., 1907. No. 87269 C.

Pump Valves.

How to Set the Valves of a Duplex Pump. F. F. Nickel. Gives simple directions, with explanatory diagrams, including also the effect and treatment of the cross-exhaust. 1200 w. Power—Oct., 1907. No. 87264 C.

Safety Appliances.

Modern Safety Devices for Prime Movers. C. C. Major. The important features of various engine-stop and speed-limit systems, and their application, are illustrated and described. 3500 w. Power—Oct., 1907. No. 87270 C.

Saturated Steam.

Physical Properties of Saturated Steam. Fred R. Low. Explains the steam tables; why temperature varies with the pressure, and what is meant by latent heat, saturated steam, etc. 4500 w. Power—Sept., 1907. No. 86668 C.

Steam Consumption.

A Graphical Table for the Determination of Steam Consumption in Large Plants by Condenser Measurements (Ueber eine Graphische Tabelle zur Bestimmung des Dampfverbrauches grösserer Aggregate aus dem Kondensat). Hans Neubauer. Gives curves and tables and describes a method of measuring steam consumption in large plants with a central condenser plant. Ills. 3000 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 17, 1907. No. 86944 D.

Superheating.

The Latest Research on the Specific Heat of Superheated Steam. Robert H. Smith. An account of recent investigations carried out at Munich, giving curves showing the new results. 2000 w. Engr, Lond—Aug. 23, 1907. No. 86739 A.

Superheated Steam for an Underground Pumping Engine at the St. Pankraz Mine at Nürschan (Heissdampf beim Betrieb einer Unterirdischen Wasserhebmaschine der St. Pankraz-Zeche in Nürschan). Julius Divis. Discusses the problem of using superheated steam underground and illustrates and describes the Nürschan plant, giving details of operation. 4000 w. Oest Zeitschr f Berg

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u Hüttenwesen—Aug. 24, 1907. No. 86945 D.

See also Railway Engineering, Motive Power and Equipment.

Thermodynamics.

The Action of Steam During Expansion. Fred R. Low. Explains why steam exerts pressure; why pressure varies with volume and temperature; and the isothermal and adiabatic conditions. 3000 w. Power—Oct., 1907. No. 87272 C.

Turbine Lubrication.

Best Method of Supplying Oil to Turbines. Thomas Franklin. Presents the advantages of the isolated oil-filtering and cooling plant, and points to be looked to in its design and operation. 2500 w. Power—Sept., 1907. No. 86673 C.

Turbines.

Compounding Piston Engines with Turbines. Prof. A. Rateau. From a paper upon the "Development of Exhaust Steam Turbines" presented to the Soc. of Belgian Engrs., describing the advantages and answering the objections to the system. 5000 w. Power—Oct., 1907. No. 87273 C.

Combined Steam Turbines (Zur Frage der Kombinierten Dampfturbinen). W. Jasinsky. A mathematical discussion of turbines constructed partly on the impulse and partly on the reaction principle. Ills. 1600 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—Aug. 30, 1907. No. 86978 D.

Turbine Tests.

See Electrical Engineering, Measurement.

MISCELLANY.

Aeronautics.

The Aeroplane Experiments of M. Louis Bleriot. Capt. Ferber. An illustrated résumé of what has been accomplished to date in France with aeroplanes of various types, including that invented by Prof. Langley. 2200 w Sci Am Sup—Sept. 14, 1907. No. 86897.

The First British Military Airship. Illustrations of the "Nulli Secundus" and report of its trial. 1500 w. Auto Jour—Sept. 14, 1907. No. 78176 A.

The Problem of Flight and Its Solution by the Aeroplane (Le Problème de l'Aviation et sa Solution par l'Aéroplane). J. Amengaud. Discusses the principles of air-ship design and reviews the work of Santos-Dumont, Ponton, Renard, and many other inventors and experimenters. 9500 w. Bull Soc d'Encour—July, 1907. No. 86917 G.

The Problem of Flight and the Resistance of the Air (Le Problème de l'Aviation et la Résistance de l'Air). E. Maleire. The first part of the serial begins a theoretical discussion of the mechanics of aerial navigation. Ills. 4800 w. Serial. 1st part. Génie Civil—Aug. 10, 1907. No. 86926 D.

Flame.

Flame Problems and Chemical Science. Prof. A. Smithells. Abstract of president's address to the Chemical Section of the British Assn. Gives a summary of the present state of knowledge with discussion of the subject in general. 6000 w. Engng—Sept. 13, 1907. No. 87215 A.

Guns.

The Dynamics of Long Recoil. A. G. Greenhill. Mathematical discussion of an ideal case, showing the nature of the calculation required in the production of a new design of long recoil. 3000 w. Engr, Lond—Aug. 23, 1907. No. 86740 A.

Rotating Discs.

The Stresses in Swiftly Rotating Discs (Die Nebenspannungen in Rasch Umlaufenden Scheibenrädern). A. Stodola. A theoretical and mathematical paper. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 10, 1907. No. 86981 D.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

The So-Called New Supplies of Anthracite. Harry W. Althouse. Showing that recent discoveries do not indicate the existence of coal beds in unexpected places. 3000 w. Eng & Min Jour—Sept. 14, 1907. No. 87008.

Briquettes.

A Brief Record of Progress in Fuel Briquette Manufacturing at Detroit. W. S. Blauvelt. 2000 w. Am Gas Lgt Jour—Sept. 23, 1907. No. 87184.

British Coalfields.

Geological Research in the Coalfields. Information from the Geological Survey of Great Britain in regard to the work in 1906. 3000 w. Col Guard—Aug. 30, 1907. Serial. 1st part. No. 87072 A.

The Geology of the Coatbridge and Motherwell and Glasgow Districts. Describes these coalfields of Great Britain. 5500 w. Ir & Coal Trds Rev—Aug. 30, 1907. No. 86876 A.

British Collieries.

A Mining Engineer's Notes of a Visit

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to England (Bergmännische Reisebriefe aus England). Martin Baldauf. The first number of the serial begins a description of some collieries near Cardiff, comparing the methods used with those in use in Germany. Ills. 1600 w. Serial. 1st part. Oest Zeitschr f Berg u Hüttenwesen—Aug. 31, 1907. No. 86946 D.

Coke Handling.

The Quenching and Handling of Coke in Gas Works (Extinction et Manutention du Coke dans les Usines à Gaz). A. Thibeault. Illustrates a method of quenching and handling coke by a current of water. 4000 w. Génie Civil—Aug. 3, 1907. No. 86924 D.

Coking.

Advantages of the By-product Coking Process. Ernest Bury. Abstract of paper read before the British Inst. of Gas Engrs. Discusses it mainly as a gas-making apparatus. 3500 w. Min Wld—Sept. 7, 1907. No. 86782.

Deposits.

The Coal Deposits of the World. A survey of the existing more or less developed coal-deposits of the world, omitting China. 1200 w. Ir & Coal Trds Rev—Aug. 30, 1907. No. 86877 A.

Electric Powers.

Electric Power in the Coal and Coke Industry. W. B. Spellmire. Brief account of applications made of electric power and the operations at the Yorkrun plant. 1000 w. Ir Age—Sept. 12, 1907. No. 86881.

India.

Coal Mining in India. Information from the annual report issued by W. H. Pickering, chief inspector of mines in India, for the year ending Dec. 31, 1906. 3000 w. Col Guard—Aug. 30, 1907. No. 86868 A.

Kentucky.

Coal Mining in Kentucky. Describes the deposits of both the eastern and western fields, giving statistics of the production, labor employed, etc. 2000 w. Min Wld—Sept. 7, 1907. No. 86783.

Mine Roofs.

Roof-Weights in Mines. H. T. Foster. Read before the Inst. of Min. Engrs. Views from observations in longwall workings, dealing with the movement of the roof, from its first disturbance to the final settling. 2000 w. Col Guard—Sept. 6, 1907. No. 87074 A.

Mining.

The Breaking Down of Undercut Ledges of Coal by Hydraulic Pressure in the Saar District (Hereingewinnung Unterschrämter Kohlenstösse mittels Hydraulischer Sprengarbeit auf Gruben des Saarbezirks). W. Mentzel. Illustrates and describes the method and the hand pump with which the hydraulic pressure is applied, giving costs. 3500 w. Glückauf—Aug. 3, 1907. No. 86937 D.

Montana.

The Montana Coal Situation. R. P. Tarr. Gives the past output, the extent of the deposits, their character and composition. 1000 w. Eng & Min Jour—Sept. 21, 1907. No. 87166.

Peat.

The Manufacture of Peat-fuel in Michigan. Francis J. Bulask. Illustrated description of the only "wet process" in use in America, with a brief outline of the industry. 1400 w. Power—Sept., 1907. No. 86671 C.

Pennsylvania.

Workable Coal Seams of Western Pennsylvania. William Seddon. Concerning the Pittsburg coal seam and various seams found below it; the thickness, extent, and comparative value. 1600 w. Eng & Min Jour—Sept. 21, 1907. No. 87165.

Westphalia.

Westphalian Collieries. An illustrated article giving impressions of a two days' visit. 3500 w. Can Min Jour—Sept. 1, 1907. No. 86762.

COPPER.

Bingham, Utah.

Mining the Porphyry Ore of Bingham. Walter Renton Ingalls. An illustrated description of these deposits in Utah, and the methods of mining. Two companies expect to produce about 80,000,000 pounds of copper yearly. Plate. 6000 w. Eng & Min Jour—Sept. 7, 1907. No. 86806.

Milling the Porphyry Ore of Bingham. Walter Renton Ingalls. Illustrated description of the mills and methods at Garfield, Utah, comparing the methods of the Utah and the Boston mills. 5000 w. Eng & Min Jour—Sept. 14, 1907. No. 87004.

Mining at Bingham, Utah. Robert B. Brinsmade. Gives the history and geology of the region, and methods of stripping and mining copper ores with steam shovels. Ills. 3500 w. Mines & Min—Sept., 1907. Serial. 1st part. No. 86772 C.

Converters.

Modern Hydraulically-Operated Copper Converters. G. B. Shipley. Describes the converter equipment for the Mammoth Copper Company at Kennet, Cal., which consists of two hydraulically-operated stands and eight shells, 96 inches in diameter by 150 inches long. Ill. 2000 w. Min Rept—Sept. 12, 1907. No. 87044.

Greenwater, Cal.

The Greenwater Mining District, Cal. O. M. Boyle, Jr. Information concerning the copper resources of this district. Ills. 1200 w. Cal Jour of Tech—Aug., 1907. No. 87098.

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Idaho.

The Seven Devils and Snake River Districts. George D. Reid. Brief illustrated description of this copper-bearing section. 1200 w. Eng & Min Jour—Aug. 31, 1907. No. 86685.

Industry.

See Industrial Economy.

Nevada.

The Genesis of the Copper Deposits of Yerington, Nevada. E. P. Jennings. Describes the interesting geological features. 1000 w. Can Min Jour—Sept. 1, 1907. No. 86763.

Ore Deposits.

Some New Points in the Geology of Copper Ores. James F. Kemp. Read before the Can. Min. Inst. Discusses secondary enrichment, and recently acquired information in regard to the geology of copper ores, and the minerals with which they are associated. 2200 w. Min Jour—Aug. 31, 1907. No. 86866 A.

Roasting Furnace.

The McDougall Roasting Furnace. L. S. Austin. Illustrates and describes a McDougall roasting plant and its operation. 1500 w. Min & Sci Pr—Aug. 31, 1907. No. 86797.

Santo Domingo.

Metallic Sulphides in the Tuffs of Santo Domingo. F. Lynwood Garrison. Outlines the geology of Santo Domingo, and describes the copper minerals found in the tuffs, discussing their characteristics and origin. Ills. 5000 w. Min & Sci Pr—Sept. 7, 1907. No. 86891.

Smelting.

Lead and Copper Smelting at Salt Lake. Walter Renton Ingalls. An illustrated article describing the smelting plants and methods, the character of the ore supply, etc. 3500 w. Eng & Min Jour—Sept. 21, 1907. Serial. 1st part. No. 87160.

Smelting in the Boundary Copper Field, B. C. Ralph Stokes. Illustrates and describes the principal smelters, stating the characteristics of the Boundary field. 3000 w. Min Wld—Sept. 21, 1907. No. 87192.

Sudbury, Ont.

The Sudbury Nickel-Copper Field, Ontario. Ralph Stokes. Remarks on last year's production with a review of the characteristics of the region and its development. Ills. 3000 w. Min Wld—Sept. 28, 1907. Serial. 1st part. No. 87295.

GOLD AND SILVER.

Alaska.

The Great Treadwell Mines on Douglas Island. Arthur Coe Spencer. Information in regard to the deposits, development, production, geology, etc., of these gold mines. Ills. 1200 w. Min Wld—Sept. 21, 1907. Serial. 1st part. No. 87194.

Alluvials.

The Occurrence of Alluvials in Hungary and Transylvania. Louis Horváth. Trans. from *Mon. Zeit.* On the prospect of working these gold-bearing alluvials on a large scale by means of dredges. 3500 w. Min Jour—Sept. 7, 1907. Serial. 1st part. No. 87071 A.

Deep Leads of Victoria, or the Cainozoic Buried Auriferous River Deposits. H. L. Wilkinson. Deals with the buried auriferous gravel deposits, the principles determining their value from the economic standpoint. 16000 w. Inst of Min & Met. Bul 35—Aug. 15, 1907. No. 87236 N.

Deep Alluvial Leads in the Mount Ida District, Otago. Moses Brown. From *Mount Ida Chronicle.* A study of the deposits of this district. 3300 w. N Z Mines Rec—July 16, 1907. Serial. 1st part. No. 87234 B.

Bullion Refining.

The Clean-Up, Melting, and Refining of Gold Bullion. Gerard W. Williams. Describes methods used on the Rand. 2500 w. Min & Sci Pr—Aug. 31, 1907. No. 86796.

Colorado.

Some Gold and Tungsten Deposits of Boulder County, Colorado. Waldemar Lindgren. Describes deposits in the southwestern part of the county. 3500 w. Ec Geol—July, 1907. No. 87090 D.

Cyaniding.

Electrolytic Recovery of Gold in Cyanide Solutions. Berrih Neumann. Abstract translation from *Zeit. für Elektrochemie.* Describes experiments made to determine the current efficiency in the electrolytic recovery of gold from cyanide solutions. 900 w. Min Rept—Sept. 12, 1907. No. 87043.

Gold Mining.

Gold Mining and Gold Production. Prof. John Walter Gregory. (Cantor Lecture.) This first lecture considers alluvial gold mines, the source of gold, washing and sluicing, dredging, methods, etc. Ills. 6500 w. Jour Soc of Arts—Sept. 13, 1907. Serial. 1st part. No. 87199 A.

Hydraulic Mining.

Débris from Hydraulic Mining in California. William W. Harts. Some account of the work done by the California Débris Commission. 1600 w. Min Rept—Sept. 19, 1907. No. 87191.

Hydraulic Mining in Cariboo. Douglas Waterman. An illustrated description of this auriferous deposit and the method used in mining. 1800 w. Min & Sci Pr—Sept. 7, 1907. No. 86890.

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The Hydraulic Equipment of the Old Channel Mines. John M. Nicol. Describes mines that have been worked for 30 years, especially the present plant and methods of working. 3000 w. Min & Sci Pr—Sept. 14, 1907. No. 87121.

Launders.

Flow of Water Carrying Sand in Suspension. F. K. Blue. An experimental study of factors which influence the relation between the velocity required and the proportion of sand in suspension. 2500 w. Eng & Min Jour—Sept. 21, 1907. No. 87162.

Mexico.

Old Methods in Mexico. Extract from a report by E. Tilmann, describing conditions at Guanajuato as they appeared forty years ago. 2500 w. Min & Sci Pr—Sept. 21, 1907. No. 87259.

The Mines of El Doctor. T. D. Murphy. An illustrated article giving the location of this district, with a review of its history and geology, and the methods of mining and treating the silver bearing ores. 4500 w. Min & Sci Pr—Aug. 24, 1907. No. 86655.

New Mexico.

The Lordsburg Mining Region, New Mexico. Fayette A. Jones. Gives the history of the region, its geology, and report of gold, silver, copper, lead and miscellaneous minerals. 1600 w. Eng & Min Jour—Sept. 7, 1907. No. 86808.

New Zealand.

Notes on Waihi Ore Treatment. Ralph Stokes. Describes the characteristics of the gold ores, and their requirements, calling attention to the honey-comb tube mill liners, the independent placing of the amalgamating house, and the vacuum slimes plant. Ills. 2800 w. Jour Chem, Met & Min Soc of S Africa—July, 1907. No. 87175 E.

Ontario.

The Montreal River Silver District. Reginald Meeks. An illustrated report of a new district, 60 miles from Cobalt, and covering an area of about 80 square miles, where native silver has been found. 2500 w. Eng & Min Jour—Sept. 21, 1907. No. 87164.

Queensland.

The Premier Goldfield of Queensland. John Plummer. An account of the discovery and development of "Charter's Towers." Ills. 1200 w. Min Wld—Sept. 14, 1907. No. 87042.

Rand.

The Past, Present, and Future of the Rand. H. C. Behr. Abstract of the president's valedictory address to the Transvaal Inst. of Mech. Engrs. Briefly considers the utilization of the power of Victoria Falls and the applications to mining. Also other improvements possible. 1500 w. Min Jour—Sept. 7, 1907. No. 87068 A.

Mining Conditions in South Africa. J. B. Pitchford. A lecture delivered to the mining students of the Univ. of Cal. Deals with the value of ore, labor conditions, mining plants and methods, and costs of mining and milling. Ills. 6500 w. Mines & Min—Sept., 1907. No. 86765 C.

Labor Conditions on the Mines. H. H. Johnson. Abstract of the president's valedictory address to the Transvaal Inst. of Mech. Engrs. Discusses methods of reducing labor costs, and other labor questions. 2500 w. Min Jour—Sept. 7, 1907. No. 87069 A.

The Commercial Aspect of Rand "Profits." George A. Denny. An examination of the situation, the working costs, and future outlook. 3500 w. Min Jour—Aug. 24, 1907. Serial. 1st part. No. 86723 A.

Inaugural Address. Prof John Yates. Discusses mining practice of the present and the future outlook, education, health of miners, depression in the mining industries, etc. 8500 w. Jour Chem, Met & Min Soc of S Africa—July, 1907. No. 86999 E.

The Origin of Gold in the Rand Banket. J. W. Gregory. States the theories advanced of the genesis of the Rand gold, describes the rocks, and investigates the evidence of the different theories, deciding in favor of the marine placer theory, giving reasons. 18000 w. Inst of Min & Met, Bul No 35—Aug. 15, 1907. No. 87235 N.

Santo Domingo.

Gold Mining in Santo Domingo. F. Lynwood Garrison. An illustrated article giving information in regard to the placer gold deposits, and the probable presence of platinum. 2500 w. Eng & Min Jour—Sept. 14, 1907. No. 87006.

Victoria.

Walhalla Goldfield, Victoria. H. Herman. An illustrated account of changes and progress during the last six years. 2000 w. Aust Min Stand—Aug. 14, 1907. Serial. 1st part. No. 87232 B.

IRON AND STEEL.

America.

The Manufacture of Steel and Wrought Iron in America. Bradley Stoughton. An illustrated review of the various processes and their characteristics, the expense and quality, the uses to which the products are applied, etc. 5000 w. Engineering Magazine—Oct., 1907. No. 87278 B.

Analysis.

The Determination of Chromium in Steel in the Presence of Tungsten (Ueber

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die Chrombestimmung im Stahl, insbesondere bei Anwesenheit von Wolfram). G. v. Knorre. A technical discussion of various methods, giving results. 3200 w. Stahl u Eisen—Aug. 28, 1907. No. 86935 D.

Blast Furnaces.

The Irondale Furnace Near Seattle, Wash. H. Cole Estep. Gives the history and illustrated description of this blast furnace on the Pacific Coast. 2500 w. Ir Trd Rev—Sept. 19, 1907. No. 87119.

Cold Blast Charcoal Furnace in Bald Eagle Valley, Pa. Illustrated description of an old blast furnace of the Curtin Iron Co., still in operation. 1600 w. Ir Trd Rev—Sept. 12, 1907. No. 86888.

Blast Furnaces at Vajda-Hunyad. Illustrated description of works in the south-east of Hungary, controlled by the Government. 1200 w. Engr, Lond—Sept. 6, 1907. No. 87083 A.

Electric Furnaces.

Electric Smelting Furnaces (Elektrische Schmelzöfen). Hermann Wilda. A descriptive and historical review of their development. Ills. 5000 w. Elektrotech u Polytech Rundschau—Aug. 7, 1907. No. 86963 D.

Electric Smelting.

The Electrothermic Reduction of Iron Ores. Albert E. Greene and Frank S. MacGregor. Results of an experimental investigation carried out at the laboratory of the Massachusetts Inst. of Technology on the electrothermic reduction of iron ores containing titanium. Ills. 3300 w. Elec-Chem & Met Ind—Sept., 1907. No. 86840 C.

The Production of Pig Iron in the Electric Furnace (Die Erzeugung von Roheisen im Elektrischen Ofen). B. Neumann. Illustrates and describes various types of furnace and reviews recent progress and investigation in electric smelting. 3300 w. Stahl u Eisen—Aug. 28, 1907. No. 86936 D.

Gas Fuel.

The Use of Producer Gas in the Chemical Industries. Oskar Nagel. States the general advantages of producer firing, and discusses its application to reverberatory furnaces, and to lime-kiln firing. Ills. 900 w. Elec-Chem & Met Ind—Sept., 1907. No. 86837 C.

Gogebic.

Progress on the Gogebic Range. Report of conditions at the various iron mines, the output, development, improvements, etc. 2500 w. Ir Trd Rev—Sept. 19, 1907. No. 87120.

Industry.

The Iron Industry in 1906 (Das Eisenhüttenwesen im Jahre 1906). B. Neumann. A statistical review of iron production in the leading countries of the world during 1906, with particular reference to Germany's position in the iron trade. 6300 w. Glückauf—Aug. 31, 1907. No. 86942 D.

Manganese Ore.

The Occurrence of Manganese Iron Ore at the Elisenhöhe at Bingerbrück (Das Manganeisenerzvorkommen der Grube Elisenhöhe bei Bingerbrück). Herr Jüngst. A detailed description of the geology of this deposit in Germany, illustrated with plans and numerous sections. 2500 w. Glückauf—Aug. 10, 1907. No. 86939 D.

Metallography.

Metallography (La Metallografia). Giulio Revere. A complete review of metallographic researches and knowledge, beginning with a consideration of iron-carbon alloys. Ills. 3300 w. Serial. 1st part. Il Monit Tech—Aug. 20, 1907. No. 86907 D.

Mexico.

The Iron Deposits of Cerro de Mercado, Durango, Mexico. Edward Halse. Historical and descriptive sketch. 1800 w. Min Jour—Sept. 17, 1907. No. 87070 A.

Osmondite.

A New Iron-Carbon Phase, Osmondite. Henry M. Howe. An account of the discovery of this new and important iron-carbon phase, showing the results, and studying the properties. 3000 w. Elec-Chem & Met Ind—Sept., 1907. No. 86834 C.

Production.

American Pig Iron Production. H. V. Luty. A review of the production since the beginning of 1905, showing the capacity of the United States, and the future increases and prospects. 2500 w. Ir & Coal Trds Rev—Sept. 13, 1907. No. 87182 A.

Rolling Mills.

A Bar Iron and Light Rail Mill. Plan and description of interesting features of a mill at Roanoke, Va. 2200 w. Ir Age—Sept. 12, 1907. No. 86880.

A Rolling Mill of the Pacific Coast. H. Cole Estep. Gives the history and a brief illustrated description of the plant of the Seattle Steel Co. 2000 w. Ir Trd Rev—Sept. 26, 1907. No. 87255.

The Bethlehem Steel Company's New Plant. Illustrated description of the 28-in. rail mill and the 28-in. structural mill at South Bethlehem, Pa. 3500 w. Ir Age—Sept. 26, 1907. No. 87227.

Slag.

Iron Slag. Dr. Theodor Koller. On the utilization of this waste product. 2700 w. Sci Am Sup—Sept. 21, 1907. No. 87128.

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Vanadium Steel.

The Effect of Vanadium in Steel. E. T. Clarage. Explains the effect on nitrogen, oxygen, and carbon and other important effects. 2000 w. Ir Trd Rev—Sept. 26, 1907. No. 87256.

MINING.

Analysis.

Technical Methods of Analysis. W. A. Seamon. Abstracted from *W. Chem. & Met.* A criticism of modern methods, with suggestions. 2500 w. Min & Sci Pr—Aug. 24, 1907. No. 86657.

Boring.

Deep Boring at Barlow, Near Selby. H. St. John Durnford. Read before the Inst. of Min. Engrs. Some notes on a deep boring recently put down. Short discussion. 2500 w. Col Guard—Sept. 6, 1907. No. 87075 A.

Boring Devices.

A New Boring Chisel (Ein Neuer Erweiterungsmeissel). Anton Pois. The first part of the serial discusses the problem of chisel boring generally, and illustrates several types of bits. 1700 w. Serial. 1st part. Oest Zeitschr f Berg u Hüttenwesen—Aug. 31, 1907. No. 86947 D.

Compressed Air.

Use of Compressed Air in Mining. Jos. H. Hart. Explains the value of hydraulic compression for mining uses. 1700 w. Min Wld—Sept. 14, 1907. No. 87041.

Economy.

Economy in Mining Operations. Thomas E. Lambert. Suggestions for the operating of mining properties. Ills. 2500 w. Min & Sci Pr—Sept. 14, 1907. No. 87122.

Electric Hoisting.

Electricity Applied to Hoisting (L'Electricité Appliquée à l'Extraction). L. Creplet. A discussion of the general problems of electric hoisting and the applications of various types of motor, giving the advantages of the use of electric power. Ills. 8000 w. All Indus—Aug., 1907. No. 86923 D.

The New Electric Hoisting Plant on the Ilgner System at the Salomon Mine at Ostrau, Moravia (Die Neue Elektrische Förderanlage Patent Ilgner am Salomon-Schachte in Mähr.-Ostrau). J. Havlicek. The first part of the serial discusses the design of Ilgner hoists and illustrates the arrangement of the machines at Ostrau. 1600 w. Serial. 1st part. Oest Zeitschr f Berg u Hüttenwesen—Aug. 3, 1907. No. 86943 D.

Electric Plant.

A Novel German Mining Electric Accumulator Plant. Frank C. Perkins. Brief description, with illustration, of the storage battery plant at the mining plant of the Gewerkschaft "Carlsfund" at Gross-Rhuden near Seesen, Germany. 600 w. Min Rept—Sept. 26, 1907. No. 87292.

Excavator.

A Stripping Excavator with a Conveyor to Form the Waste Bank. Illustrated description of an interesting combination of excavating and conveying plant designed to meet special conditions in the stripping of coal lands. 1200 w. Eng News—Sept. 12, 1907. No. 87001.

Explosives.

Modern Explosives (Les Explosifs Modernes). H. Schmerber. A review of the preparation, manufacture, and use of modern high-power explosives, in view of recent explosions on shipboard, the first part of the serial outlining the general principles of the theory of explosives. Ills. 3000 w. Serial. 1st part. Génie Civil—Aug. 31, 1907. No. 86929 D.

Finance.

Mining Stocks and Mining Engineers. Francis C. Nicholas. Gives reasons why mining engineers should have more intimate relations with bankers and brokers who have mining stock for sale. 2000 w. Min Wld—Sept. 7, 1907. No. 86781.

Granby, Mo.

Mining and Smelting at Granby, Missouri. Edwin T. Perkins. Describes the geology and deposits of this zinc-lead district; how the ores are mined, treated and smelted and the mines developed. 2500 w. Eng & Min Jour—Aug. 31, 1907. No. 86683.

Locating Claims.

State Provisions for Location of Lode Claims. R. S. Morrison. Explains the procedure necessary in Nevada to secure a claim. 2500 w. Ores & Metals—Sept. 5, 1907. No. 86813.

Locomotives.

Unique European Electric Mining Locomotives. Frank C. Perkins. Illustrates and describes types used in Austria, Germany, and Belgium. 2500 w. Min Wld—Sept. 7, 1907. No. 86780.

Machinery.

The Mechanical Engineering of the Mine. Charles C. Christensen. An illustrated summary of machinery that has become an important factor in the mining, treatment, and dressing of ore. 5500 w. Engineering Magazine—Oct., 1907. No. 87277 B.

Milling.

The Humphreys' Quartz Mill. C. E. Humphreys. Brief illustrated description of a mill embodying the pounding principle of the stamp-mill and the grinding-amalgamating principles of the arrastre. 900 w. Min Rept—Sept. 26, 1907. No. 87293.

Mules.

Care of Mine Mules. Dr. I. C. New-

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hard. An illustrated article giving information in regard to feed and feeding, harnessing, shoeing and care of hoofs, stables, etc. 3000 w. Mines & Min—Sept., 1907. No. 86766 C.

Plant.

A New Mine Plant in Germany. B. F. Hirschauer. Illustrated description of an interesting installation at the Thiederhall mines, near Brunswick. 1500 w. Elec Rev, N Y—Sept. 28, 1907. No. 87302.

Reinforced Concrete.

Reinforced Concrete in Mining Operations. Joseph H. Hart. Calls attention to the chief applications thus far. 1500 w. Min Wld—Sept. 28, 1907. No. 87296.

Shaft Plumbing.

A New Method of Shaft Connection. Henry Briggs. Discusses the causes of deflection of the wires in shafts, and proposes a new method, stating the advantages. 1800 w. Eng & Min Jour—Sept. 14, 1907. No. 87005.

Shaft Sinking.

Sinking of Bentley Colliery. J. W. Fryar and Robert Clive. Read before the Inst. of Min. Engrs. An account of difficult sinking through quicksand. 3000 w. Col Guard—Sept. 6, 1907. No. 87073 A.

Sinking Pumps.

Improvements in the Vertical-plunger Sinking Pump. A. H. Hale. Discusses defects in the design of sinking pumps suggesting improvements. Ills. 1200 w. Power—Sept., 1907. No. 86672 C.

Stores Keeping.

Keeping Account of Supplies. Matt. W. Alderson. The present article is introductory to a discussion of methods of accounting for mining supplies. 1200 w. Min & Sci Pr—Aug. 31, 1907. Serial. 1st part. No. 86794.

Tailings Disposal.

Dumping Residue at Kalgoorlie. M. W. von Bernewitz. An illustrated article explaining conditions and showing the necessity of using conveyors. 900 w. Min & Sci Pr—Sept. 21, 1907. No. 87258.

Timbering.

Setting Timber in Anthracite Coal Mines. John H. Haertter. Gives reasons why it would be impracticable to have a special timber corps instead of having the props placed by the miners. Ills. 3300 w. Eng & Min Jour—Aug. 31, 1907. No. 86686.

Timbering Mines in the Joplin District, Missouri. Doss Brittain. Illustrates and describes methods of timbering during sinking and driving through soft and loose ground in use in the lead and zinc mines of this region. 2000 w. Ores & Metals—Sept. 5, 1907. No. 86812.

Square-Set Mining and a Modification of It. Claude T. Rice. Outlines a method proposed to better square-set practice. 3500 w. Min & Sci Pr—Sept. 21, 1907. No. 87257.

Unwatering.

The Unwatering of Mines in the Anthracite Region. R. V. Norris. An illustrated description of pumping methods used, their cost, etc. 4000 w. Engineering Magazine—Oct., 1907. No. 87284 B.

Vancouver Island.

Metalliferous Mining on West Coast of Vancouver Island. Notes, with illustrations, of various mining properties on the island. 7500 w. B C Min Rec—July, 1907. No. 86815 B.

Ventilation.

Concrete Overcasts in Coal Mines. John H. Haertter. Illustrates and describes methods of construction, and advantages of concrete and steel over wood in ventilating coal mines. 2500 w. Eng & Min Jour—Sept. 7, 1907. No. 86809.

Test of a Mine Fan at the Zinc-Lead Mine, Neu-Diepenbrock III (Untersuchung eines Grubenventilators auf der Zink- und Bleierzgrube Neu-Diepenbrock III). Describes the method of testing and gives the results in tables and curves. 2000 w. Glückauf—Aug. 3, 1907. No. 86938 D.

Wire Ropes.

A Few Notes on Results of Tests of Worn Ropes. W. Martin Epton. Read before the Trans. Inst. of Mech. Engrs. Gives results of ninety complete tests of worn wire ropes. Also short discussion. 2000 w. Min Jour—Aug. 31, 1907. No. 86867 A.

Württemberg.

The History of Mining in Württemberg (Württembergs Erzbergbau in der Vergangenheit). Axel Schmidt. A historical review of silver, copper, cobalt, nickel, and iron mining industry in this district of Germany. 5000 w. Glückauf—Aug. 17, 1907. No. 86941 D.

MISCELLANY.

Antimony.

Notes on Antimony Smelting. G. Pautrat. From *Revue di Chimie Ind.* Describes the plant and processes employed at a smelter in Mayenne, France, for the production of antimony metal and oxides from stibnite ore. 1500 w. Eng & Min Jour—Sept. 14, 1907. No. 87007.

Asbestos.

Asbestos; Its Mining, Preparation, Markets and Uses. E. Schaaf-Regelman. An illustrated review of the evolution of this industry and the production and uses. 3500 w. Engineering Magazine—Oct., 1907. No. 87279 B.

Asbestos Mining in the United States. J. S. Diller. Brief accounts of producing districts. 1500 w. Min Wld—Sept. 21, 1907. No. 87193.

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Borax.

The Borax Deposit of Salinas, Near Arequipa, Peru. A. Jochamowitz. Describes this deposit, considering its origin and constitution. 1500 w. Min Jour—Aug. 24, 1907. No. 86725 A.

Cornwall.

The Quantity of Tin, Copper, and Other Minerals Produced in Cornwall. Statistics concerning the output as determined by published records. 700 w. Ir & Coal Trds Rev—Aug. 30, 1907. No. 86878 A.

Diamonds.

The Origin and Occurrences of the Diamond. Prof. T. W. E. David. A review of the occurrence of diamonds in matrix, with a discussion of the genesis of Oakley Creek diamonds in New South Wales. 3300 w. Min Jour—Aug. 24, 1907. No. 86724 A.

The Origin of Diamonds. Dr. F. W. Voit. Read before the Geol. Soc. of S. Africa. Discusses the origin of the diamond in pipes, basing the theory on the manner in which the diamond can be artificially produced. 2500 w. Min Jour—Sept. 14, 1907. No. 87181 A.

Exposition.

See Industrial Economy.

Fluorspar.

Fluorspar. Ernest F. Burchard. Considers its character, occurrence, preparation, and uses, market conditions, and production in 1906. 1500 w. Min Rept—Sept. 26, 1907. No. 87294.

Gypsum.

Montana Gypsum Deposits. J. P. Rowe. Describes the deposits in different localities, developments, mills, geological formation, etc. Ills. 2500 w. Mines & Min—Sept., 1907. No. 86767 C.

Laboratory.

Laboratory of the Coffeyville Zinc Works. E. W. Buskett. Illustrated description of laboratory equipment. 1000 w. Eng & Min Jour—Sept. 21, 1907. No. 87163.

Lead Assay.

Some Practical Notes on the Lead Assay. C. A. Cooper. Discusses the treatment of a medium grade concentrate and a zinc concentrate low in lead. 2000 w. Min Wld—Sept. 21, 1907. No. 87195.

Lime Burning.

A New Regime in Lime-Burning Furnaces (Sopra un Nuovo Regimé nei Forni per la Cottura della Calce). Frederico Carini. A paper presented before the Milan Chemical Society, discussing hearth, regenerative, and other furnaces. 2800 w. Serial. 1st part. L'Industria — Aug. 25, 1907. No. 86905 D.

Mexico.

The West Coast of Mexico. Dwight E. Woodbridge. Notes on the resources of the country, the transportation, business methods, and labor conditions. 2700 w. Eng & Min Jour—Aug. 31, 1907. No. 86684.

New Caledonia.

New Caledonia and Its Minerals. G. M. Colvocoresses. Information in regard to the geography, geology, and mineral resources of an interesting island in the South Pacific, its discovery, exploration and settlement. Ills. Nickel, chrome and cobalt ores are the chief minerals exported. 2500 w. Eng & Min Jour—Sept. 21, 1907. No. 87161.

New Zealand.

The Mining Industry of New Zealand. P. E. Cheal. Some suggestions for its development. 6800 w. N Z Mines Rec—June 17, 1907. No. 86854 B.

Oil.

Oil in the State of Vera Cruz. Ezequiel Ordonez. Describes the conditions prevailing in this part of Mexico, and shows that they extend over quite a zone of the Gulf-coast lands. Ills. 2000 w. Min & Sci Pr—Aug. 24, 1907. No. 86656.

Pyrite.

The Oxidation of Pyrite. Alexander N. Winchell. An account of experimental investigations with pure water, charged only with air, to determine the rate of oxidation under favorable conditions. 1300 w. Mines & Min—Sept., 1907. No. 86768 C.

Rutile.

Occurrence of Rutile in Virginia. Thomas Leonard Watson. Gives results of field and laboratory study of the occurrence of rutile in the Virginia area. Ills. 2800 w. Ec Geol—July, 1907. No. 87092 D.

Tin.

Tingha Tin Dredging Industry (N. S. W.). P. J. Thibault. Introduction to articles dealing with the tin dredging plants in operation on this field. 1200 w. 'Aust Min Stand—Aug. 7, 1907. Serial. 1st part. No. 87099 B.

Turquoise.

Turquoise in the Burro Mountains, New Mexico. Edward R. Zalinski. The geology of the turquoise deposits, the composition, genesis, etc., are considered. Ills. 8000 w. Ec Geol—July, 1907. No. 87091 D.

Zinc.

Open-pit Zinc Mine at Webb City, Missouri. F. Lynwood Garrison. Illustrations, with brief description of features of interest. 600 w. Eng & Min Jour—Aug. 17, 1907. No. 86427.

The Treatment of Zinc Ores in Colorado. F. W. Traphagen. Briefly discusses the several methods of treatment. 2500 w. Mines & Min—Aug., 1907. No. 86094 C.

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The Zinc Smelting Works of Swansea, Wales. Edward Walker. An illustrated description of six smelters which produce about 450 tons a week, mostly from custom ores and partly from ores imported from Italy and Africa. 1200 w. Eng & Min Jour—July 27, 1907. No. 85954.

Zinc-Lead.

The Kelly Mine, New Mexico, and Treatment of Its Ores. Woolsey McA. Johnson. An illustrated article describing the geology of the deposits of zinc-lead, their mining, concentration, etc. 2000 w. Min Wld—Aug. 17, 1907. No. 86444.

The Lead and Zinc Fields of Southwestern Wisconsin. George E. Edwards. Describes this district lying in Iowa, Illinois, and Wisconsin, and the deposits of lead and zinc, methods of mining, etc. 2500 w. Min Wld—Aug. 17, 1907. No. 86447.

Zinc-Lead Pigments.

Zinc-Lead Pigment Plant of United States Smelting Company, Canon City, Colorado. Pierce Barker. Brief description of a plant for the manufacture of zinc-lead pigment using a modification of the Lewis and Bartlett process. 700 w. Min & Sci Pr—Sept. 5, 1907. No. 86798.

Zinc Milling.

Differentiation by Leaching in the Wisconsin Zinc Region. H. A. Wheeler. Describes changes in this district by leaching action. 1500 w. Eng & Min Jour—Aug. 17, 1907. No. 86430.

Zinc Ores.

Zinc Ore and Manufactures Therefrom. W. G. Scott. Information concerning the ores of zinc and the uses made of it. 2500 w. Min Wld—Sept. 14, 1907. No. 87040.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Track Reversal.

Reversal of Track Running on the New York Central. An account of recent changes in running of trains and in signaling on the electric lines of the N. Y. C. & H. R. 1200 w. R R Gaz—Aug. 30, 1907. No. 86660.

Waste of Energy.

The Waste of Energy in Railroad Operation. D. C. Buel. Abstract of a paper presented before Trav. Engrs.' Assn. Calls attention to the channels through which energy is wasted. 2500 w. Ry & Engng Rev—Sept. 7, 1907. No. 86801.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Variable Pressure Mechanism for Air Brakes. Illustrates and describes a mechanism operated and controlled by the friction of the shoe with the wheel, varying the shoe pressure without wasting the air pressure. The new brake is called the "Maximus." 1000 w. Sci Am—Aug. 31, 1907. No. 86678.

Locomotive Design.

Curiosities of Locomotive Design. From Development of the Locomotive Engine, by Angus Sinclair. Illustrates and describes some odd inventions in this field. 1800 w. Ry & Loc Engng—Sept., 1907. No. 86704 C.

Locomotives.

A New Continental Locomotive Type. Illustrated description of the Pacific (4-6-2) type compound engine for the Paris-Orleans Ry. 800 w. Mech Engr—Aug. 24, 1907. No. 86718 A.

Goods Locomotive for the Lancashire and Yorkshire Railway. Illustrates and describes interesting particulars of the 1000th locomotive built by this railway company. Plate. 800 w. Engng—Aug. 23, 1907. No. 86736 A.

Recent Locomotives and Carriages on the L. & Y. Railway. Brief illustrated account of the Lancashire and Yorkshire Railway Locomotive Works and of engines and cars built there. 1700 w. Engr, Lond—Aug. 30, 1907. No. 86874 A.

British 4-Cylinder Locomotives. Charles S. Lake. General discussion of the advantages and disadvantages of these engines, with illustrations and brief descriptions of recent types. 1600 w. Ry Age—Sept. 27, 1907. No. 87286.

Recent British Locomotives for Abroad. Illustrated description of locomotives lately shipped to Ceylon, South America, and Brazil. 1000 w. Mech Engr—Aug. 31, 1907. No. 86857 A.

Pacific Locomotive for the Pennsylvania Lines West. Illustrated description of a 4-6-2 locomotive, which is the heaviest passenger engine that has been built up to the present time for any road. 1500 w. R R Gaz—Aug. 30, 1907. No. 86663.

The Locomotives of the Atchison, Topeka and Santa Fe Railway. Map showing the extent of this system, with illustrated descriptions of types of locomotives used and account of the service. 3000 w. Engr, Lond—Sept. 13, 1907. No. 87217 A.

Mallet Articulated Compound Locomotive, 0-8-8-0 Type. Full illustrated detailed description of the first of an order of three pushing locomotives for the Erie

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R. R., which break all records of weight, size and power. 2000 w. Am Engr & R R Jour—Sept., 1907. No. 86803 C.

A Note on Compound Locomotives. M. Maurice Demoulin. An examination of data relating to compound locomotives, with personal opinions. 3500 w. Engr, Lond—Aug. 23, 1907. Serial. 1st part. No. 86738 A.

The Development of the Bavarian Locomotive and its Representatives at the Nürnberg Exhibition, 1906 (Die Entwicklung des Bayerischen Locomotivbaues und dessen Erzeugnisse auf der Jubiläums- und Landesausstellung in Nürnberg,1906). Julius Weil. A historical review and a description of recent productions. 1800 w. Serial. 1st part. Elektrotech u Polytech Rundschau—Aug. 28, 1907. No. 86965 D.

Locomotive Testing.

Some Important Results from the Pennsylvania Railroad Testing Plant at St. Louis. A convenient table containing results obtained from locomotives tested at the St. Louis Fair. 800 w. Am Eng & R R Jour—Sept., 1907. No. 86804 C.

Milan Exposition.

Railway Rolling Stock at the Milan Exposition (Le Matériel Roulant des Chemins de Fer à l'Exposition de Milan). L. Georges. The first number of the serial gives an elaborate, detailed description of the various types of locomotives shown, illustrated by many plates and drawings. 20000 w. Serial. 1st part. Rev Gen d Chemins d Fer—Aug., 1907. No. 86922 G.

Repairs.

Co-operation Between the Operating and Mechanical Departments. A. W. Wheatley. Suggestions for decreasing the cost of locomotive repairs. 1000 w. Am Engr & R R Jour—Sept., 1907. No. 86805 C.

Smoke.

Eliminating Smoke with Locomotives Burning Soft Coal. Abstract of a report presented at meeting of the Traveling Engrs.' Assn. Gives the recommendations of the committee. 2000 w. Eng News—Sept. 19, 1907. No. 87114.

Smoke Box.

Locomotive Smoke-Box Arrangements. E. W. Rogers. Gives examples of typical types of smoke-box arrangements which are in use to-day, and the methods of laying out this part of the boiler. Ills. 1600 w. Boiler Maker—Sept., 1907. No. 86666.

Superheating.

Superheated Steam Locomotives in Germany. An illustrated review of the use of superheated locomotives on the Prussian State Railways, the improvements made, and a brief description of the latest locomotives. 2700 w. Mech Engr—Sept. 14, 1907. No. 87204 A.

Superheated Steam Passenger Locomotive, Series B¾, of the Swiss State Railways (Heissdampf-Personenzugslokomotive Serie B¾ der Schweizerischen Bundesbahnen). M. Weiss. An illustrated detailed description of two locomotives recently put in service. 2300 w. Schweiz Bau—Aug. 3, 1907. No. 86958 D.

Washing Boilers.

Modern Method of Washing Locomotive Boilers. E. J. Harris. Describes the Miller system and the improvements introduced by D. W. Cunningham. 1600 w. Pro Iowa Ry Club—June 14, 1907. No. 87226 C.

NEW PROJECTS.

Current Construction.

Current Railway Construction. Notes on the new works in progress in Great Britain and Ireland. 1800 w. Engng—Aug. 23, 1907. No. 86735 A.

Cut-Off.

A New Transcontinental Cut-Off for the Southern Pacific and the Santa Fe. Map showing present location of lines and indicating the probable cut-off, with explanatory notes. 2200 w. R R Gaz—Aug. 30, 1907. No. 86661.

Florida.

Florida East Coast Railway Extension. Howard Egleston. Map, with brief illustrated review of the work done, and an account of the work necessary to complete the line. 13000 w. Engng-Con—Sept. 4, 1907. Serial. 1st part. No. 86831.

Splugen.

The Splügen Railway. From *Schweizerische Bauzeitung*. Information in regard to this proposed line. 3900 w. Bul Int Ry Cong—Aug., 1907. No. 86852 E.

PERMANENT WAY AND BUILDINGS.

Buildings.

The Cost of Four Frame Depots. The first of a series of articles on the cost of railway buildings. Itemized cost of labor and materials will be given, also standard plans and bills of materials. 2000 w. Engng-Con—Aug. 28, 1907. Serial. 1st part. No. 86650.

Coal Yard.

The Coal Yard at Cologne Station (Eifeltor). C. Guillery. Trans. from *Zeit. des Ver. deut. Ing.* Illustrated description of a plant for the supply of coal to locomotives. 2000 w. Bul Int Ry Cong—Aug., 1907. No. 86851 E.

Culverts.

A Method of Tunneling High Railroad Embankments for Culverts. Describes reinforced concrete culverts built in tunnels driven through the embankments. Ills. 1500 w. Eng Rec—Sept. 7, 1907. No. 86791.

Easement Curves.

A Unit Table for Talbot's Spiral. Gives

We supply copies of these articles. See page 397.

a table, based on Talbot's Spiral, compiled by G. A. Kyle, adapted to any length up to 400 ft. varying by whole feet. 3000 w. Eng Rec—Sept. 7, 1907. No. 86788.

Grade Crossings.

Elimination of Grade Crossings in New York Central Electric Zone. Illustrates and describes the High Bridge and Morris Heights stations where overhead bridges are used. 1500 w. Eng Rec—Sept. 7, 1907. No. 86790.

Rail Corrugation.

The Lack of Perfect Regularity of the Rolling Surface of Certain Hard-Steel Rails and the Inconveniences which Result from it (Note sur le Défaut de Nivellement Parfait de la Surface de Roulement de Certains Rails en Acier Dur et les Inconvénients qui en Résultent). E. Perroud. Observations on rail corrugation on the Northern Railway of France. Ills. 6600 w. Rev Gen d Chemins d Fer—Aug., 1907. No. 86921 G.

Shops.

Car Repair Shops at East Decatur, Ill. Illustrated description of shops for the Wabash Railroad. 2500 w. Ry Mas Mech —Sept., 1907. No. 87100.

The New Springfield (Mo.) Shops of the Frisco System. Plan and description of a large locomotive repair plant under construction for the St. Louis and San Francisco System. 2500 w. Ry Age—Sept. 6, 1907. No. 86799.

Stations.

The Construction and Arrangements of the New German-Russian Frontier Station at Skalmierzyce with Particular Reference to Its Mechanical Equipment (Bau- und Betrieb des Neuen Preussisch-Russischen Grenzbahnhofs Skalmierzyce in Maschinentechnischer Beziehung). Hans A. Martens. Ills. 6000 w. Glaser's Ann—Aug. 15, 1907. No. 86969 D.

Terminals.

Proposed Improvement of Passenger and Freight Terminals at Buffalo. Report, with illustrations, of a proposed union passenger station and freight terminals, explaining the complex railroad situation at Buffalo. 3500 w. Ry & Engng Rev—Aug. 31, 1907. No. 86699.

Ties.

Kimball Concrete-Steel Ties. Illustrates and describes a type of reinforced-concrete tie now being tested on the Chicago & Alton and the Pere Marquette. 700 w. Ry Age—Sept. 20, 1907. No. 87190.

Transfer Bridge.

Electrically Operated Transfer Bridge. Illustrated description of the transfer bridge of the N. Y. C. & H. R. R. Co., installed at points where freight-cars are transferred from water to land, or land to water. 1000 w. Elec Age—Sept., 1907. No. 87263.

Turntables.

Modern Turntables. Remarks on changes required by the increase in length and weight of locomotives, with illustrated descriptions of recent types for different lines. 1200 w. Ry Age—Sept. 13, 1907. Serial. 1st part. No. 87045.

TRAFFIC.

Freight.

The Railroad Situation. Address of W. W. Finley before the American Association of Freight Traffic Officers, at Chicago. 3500 w. Ry & Engng Rev—Sept. 21, 1907. No. 87174.

On the Reform of Freight Traffic on the Prussian State Railways (Ueber die Reform des Güterverkehrs auf den Preussischen Staatseisenbahnen). Herr Schwabe. Describes the improvements in rolling stock and in methods of handling freight and conducting transportation which have taken place in recent years. Ills. 6000 w. Zeitschr d Oest Ing u Arch Ver—Aug. 30, 1907. No. 86974 D.

Rates.

Export Railway Rates in Austria-Hungary, Italy, etc. Particulars concerning the special tariff system of Austria-Hungary, Italy, and one or two other countries. 2000 w. Engng—Sept. 13, 1907. No. 87213 A.

MISCELLANY.

Legislation.

Railroad Legislation In Pennsylvania. A summary of some of the less important acts recently passed, with some details of the Railroad Commission Law. 1000 w. RR Gaz—Aug. 30, 1907. No. 86658.

Regulation.

Railroad Regulation. Walker D. Hines. Address before the Traffic Club of New York. Considers the laws already passed sufficient for the correction of every real evil. 2000 w. Ry Age—Sept. 27, 1907. No. 87288.

Review.

The Railways in 1905-1906. The results of working the railways during 1905 in France, England and Germany. 6800 w. Bul Int Ry Cong—Aug., 1907. No. 86853 E.

Southern Railway.

Relation of Railways to the Public. W. W. Finley. From an address at Atlanta, Ga. A brief review of transportation conditions in the Southern States, and the policy of the Southern Railway. 5500 w. Ry & Engng Rev—Sept. 7, 1907. No. 86802.

U. S. Railways.

Statistics of the Railways of the United States for 1906. An interesting summary from Poor's Manual, showing the remarkable railway activities. 2500 w. Eng News —Sept. 5, 1907. No. 86758.

We supply copies of these articles. See page 397.

STREET AND ELECTRIC RAILWAYS

Austria.

The Open Lines of the New Alpine Railways (Die Offenen Strecken der Neuen Alpenbahnen). J. Zuffer. Describes particularly the permanent way, the tunnels, bridges, etc., giving plan and profile and tables of details of construction. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Aug. 2, 1907. No. 86970 D.

Chicago.

Pay-As-You-Enter Cars and Dispatching System in Chicago. An illustrated account of changes to be made in Chicago as given in a report from T. E. Mitten. 2500 w. Elec Ry Rev—Sept. 21, 1907. No. 87172.

Electrification.

Middletown-Berlin Electrification of the New York, New Haven & Hartford Railroad Company. An illustrated description of the electrification of a branch line, 9.53 miles in length. 1200 w. St Ry Jour—Sept. 21, 1907. No. 87170.

The Installation of Electric Traction on the New York Terminal Section of the New Haven Railroad. An introductory explanation with illustrated description of the installation between Woodlawn Junction and Stamford. 11300 w. Eng News—Sept. 5, 1907. No. 86755.

Reports of the Swiss Commission for Studying the Electrification of the Railways. W. Wyssling. (Abstract.) On the quantity of power required to operate the Swiss railways by means of electric traction. 7600 w. Bul Int Ry Cong—Aug., 1907. No. 86850 E.

Indiana.

The Evansville and Eastern Traction System. Features of interest on this new line in Indiana are illustrated and described. 1800 w. St Ry Jour—Sept. 28, 1907. No. 87297.

Locomotives.

Metropolitan Railway Electric Locomotives. Illustrated description of the electric locomotives for passenger and freight service on the Metropolitan Railway of London. 1800 w. St Ry Jour—Sept. 7, 1907. No. 86778.

Electric Locomotives. H. L. Kirker. Address before the Grand Trunk Ry. Literary & Scientific Inst. of Port Huron, Mich. 2500 w. Elec Age—Aug., 1907. No. 86703.

Electric Locomotives on Mountain Grades. Editorial discussion of the advantages of electric traction over steam on mountain grades of railways. 1500 w. Eng Rec—Aug. 17, 1907. No. 87233.

Los Angeles, Cal.

Track and Roadway of the Pacific Electric and Los Angeles Interurban Railways. Map showing the territory served by these companies, with an illustrated description of recent track work. 1200 w. Elec Ry Rev—Aug. 31, 1907. No. 86695.

Manchester, Eng.

Manchester Corporation Tramways. Indicates the scope of this undertaking, illustrating special track work, rolling stock and other features of interest, and describing methods of operation. 2500 w. Tram & Ry Wld—Sept. 5, 1907. No. 87052 B.

Motors.

Commutating-Pole Direct-Current Railway Motors. E. H. Anderson. Briefly reviews the important developments in railway motors, discussing in detail the motor named and stating its advantages as compared with the non-commutating pole type. 3000 w. Pro Am Inst of Elec Engrs—Aug., 1907. No. 87144 D.

Regeneration of Power with Single-Phase Electric Railway Motors. William Cooper. Describes a system of regenerating power which has been thoroughly tested. 2700 w. Pro Am Inst of Elec Engrs—Aug., 1907. No. 87142 D.

1200-Volt and Commutating-Pole Direct-Current Railway Motors. E. H. Anderson. Read before the Cent. Elec. Ry. Assn. Reviews briefly features in the development of railway motors, explaining the advantages of commutating-pole motors. 3000 w. Elec Ry Rev—Sept. 28, 1907. No. 87300.

The Characteristic Curves of Rotating-Current Motors with Change-Speed Gear for the Requirements of Electric Traction (Ueber die Charakteristischen Kurven von Drehstrommotoren mit Stufenregelung der Umdrehungszahl für die Bedürfnisse der Elektrischen Traktion). Dr. W. Kummer. A theoretical and mathematical paper. Ills. 3000 w. Serial. 1st part. Schweiz Bau—Aug. 31, 1907. No. 86961 D.

Power Station.

Cos Cob Power Station, New York, New Haven & Hartford Railroad Company. Illustrates and describes this station, of interest as a part of the first installation of single-phase electric equipment for the operation of a trunk line railway. 3500 w. St Ry Jour—Aug. 31, 1907. No. 86697.

Rails.

Standardization of Rail Sections of the German Street & Interurban Railway Association. Gives a report recently pre-

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sented at Mannheim, Germany, in which fifteen sections are proposed for standardization. 1500 w. St Ry Jour—Sept. 14, 1907. No. 87039.

Reconstruction.

Reconstruction of the South Side Elevated Railroad, Chicago. Illustrates and describes the work of changing grade and alignment, and other improvements. 2500 w. Elec Ry Rev—Aug. 31, 1907. No. 86696.

Rules.

Report of Committee on Interurban Rules. A report of the rules adopted at the Kingston meeting of the Street Railway Association of the State of New York, Sept. 21, 1907. 12000 w. St Ry Jour—Sept. 28, 1907. No. 87298.

Service Tests.

Service Tests on Columbus City Cars Operated Singly and in Two-Car Trains with Multiple Unit Control. Gives a summary of tests made by the Ohio State University's Department of Electrical Engineering. 2000 w. St Ry Jour—Aug. 31, 1907. No. 86698.

Shops.

Concrete Shops and Car Houses at Nashville. Illustrated description of shops representing the most advanced ideas in fireproof construction and in arrangement for facilitating car repairs. 1200 w. St Ry Jour—Sept. 14, 1907. No. 87038.

Signaling.

Track-Circuit Signaling on Electrified Roads. L. Frederic Howard. Traces the development of track-circuit apparatus during the last ten years, showing the relations existing between the track-circuit system and the propulsion system on electrified roads. Ills. 4000 w. Pro Am Inst of Elec Engrs—Aug., 1907. No. 87145 D.

The Electric Signals on the Paris Metropolitan Railway. A Soulier. Translated from *L'Ind. Elec.* Describes the two types of the Hall automatic block system installed; the track circuit system, and the pedal system. Ills. 2000 w. Elect'n, Lond—Aug. 30, 1907. No. 86864 A.

Standardization.

Report of the German Street and Interurban Railway Association's Committee on Standardization. Abstract translation. 3300 w. St Ry Jour—Sept. 7, 1907. No. 86779.

Station.

The Double-Deck Surface and Tunnel Station of the Hudson Companies in Jersey City. Outlines the extensive engineering works in progress to connect Jersey City and Manhattan Island, and gives an illustrated description of the underground station, below the present terminal of the Pennsylvania Railroad in Jersey City. 1800 w. Sci Am—Sept. 21, 1907. No. 87124.

Stubai.

The Stubai Valley Railway (Die Stubaitalbahn). An illustrated description of this Alpine railway which was the first to use high-frequency alternating current. 1800 w. Serial. 1st part. Elektrotechniker—Aug. 25, 1907. No. 86962 D.

Substations.

Substations of the Los Angeles Railway. Brief illustrated description. 1200 w. Elec Ry Rev—Sept. 14, 1907. No. 87037.

Tacoma, Wash.

The Pacific Coast Traction Company, Tacoma, Washington. An illustrated account of a new line to American Lake from Tacoma, built mostly on private right of way. 1000 w. St Ry Jour—Sept. 7, 1907. No. 86777.

Third Rail.

Third Rail Design. E. Goolding. States the necessary requirements and gives illustrations of types in use with critical notes. 1300 w. Tram & Ry Wld—Sept. 5, 1907. No. 87053 B.

Train Testing.

Improved Interurban Train Testing Apparatus. Sidney W. Ashe. An illustrated article describing improvements which greatly simplify the method of making up results. 1200 w. St Ry Jour—Aug. 24, 1907. No. 86541.

Transmission Systems.

High-Voltage Direct-Current and Alternating-Current Systems for Interurban Railways. W. J. Davis, Jr. Also discussion at Chicago. 4400 w. Pro Am Inst of Elec Engrs—Aug., 1907. No. 87148 D.

Trunk Lines.

Electric Trunk Line Operation. Briefly considers the three electric systems proposed for the operation of trunk lines and the advantage of each. 2500 w. Elec Age—Aug., 1907. No. 86700.

Discussion on "Some Facts and Problems Bearing on Electric Trunk-Line Operation," at New York, May 21, 1907. Discussion of paper by Mr. Frank J. Sprague. 16000 w. Pro Am Inst of Elec Engrs—Aug., 1907. No. 87146 D.

Tunnels.

The Selby Hill Street Railway Tunnel, St. Paul, Minn. Illustrates and describes recently completed work which greatly reduces a steep grade on an important street railway line. 3500 w. Eng Rec—Sept. 21, 1907. No. 87149.

Vienna-Baden.

The Rolling Stock of the Single-Phase Vienna-Baden Inter-Urban Line. Illustrates and describes the car equipment, giving full details of the controlling and braking systems. Adapted to use on both single-phase and direct-current circuits. 3000 w. Elect'n, Lond—Aug. 30, 1907. No. 86862 A.

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EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Mass.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Verkehrstechnische Woche und Eisenbahntechnische Zeitschrift. *w.* Berlin.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Bins.

The Design of Walls, Bins and Grain Elevators. By Milo S. Ketchum. Size, 9 by 6½ in.; pp., xiv, 394. Ills., 260. Tables, 40. Price, $4. New York: The Engineering News Publishing Company; London: Archibald Constable and Company.

Those familiar with Prof. Ketchum's book on Steel Mill Buildings will welcome this pioneer treatise on bin design, which is characterized by the same thoroughness, clearness, and logical and systematic arrangement displayed in the former volume. Since a thorough understanding of the theory of the retaining wall is essential to a correct understanding of the theory of the pressure of granular materials in bins, the author devotes considerable space to a discussion of the various retaining-wall theories and their application to actual design. The second part of the book is devoted to the design of bins for the storage of coal, ore, etc., and the concluding section takes up in detail the design of grain bins and elevators. The extensive use of reinforced concrete in this class of work is recognized and considerable space is given to a discussion of the theory of reinforced concrete construction and to the development of the formulæ necessary for use in the design of walls, bins and grain elevators. Appendices give a glossary of masonry terms and sets of standard specifications for stone-masonry, concrete and steel construction. A valuable feature of the book is to be found in the tables of costs of actual structures which are included wherever possible and analyzed so thoroughly as to be of the greatest assistance and value. For practical data and scientific and theoretical accuracy, Prof. Ketchum's book can be recommended to the student and practicing engineer alike.

Civil Service Examinations.

Manual of Examinations for Engineering Positions in the Service of the City of New York. By Myron H. Lewis and Milton Kempner. Size, 9 by 6 in.; pp., about 600. Ills. Price, $5. New York: The Engineering News Publishing Company.

The main body of this book is divided into eight parts covering respectively, examinations for the positions of axeman; chainman and rodman; leveler; transitman and computer; assistant engineer—Rapid Transit Commission; assistant engineer—general, aqueduct, docks, sewers, and highways; draftsman and draftsman's helper; inspector—buildings, masonry and carpentry, steel, regulating, grading, and paving, and sewers; and two appendices giving useful formulæ for surveyors and civil engineers. Under each section are given sets of previous examination questions for the various positions and a number of typical questions with full answers. Two general appendices to the volume give information and previous examination papers of the civil service of the United States, State of New York, Cities of Buffalo, Boston, New Orleans, etc. The book is likely to be of value to examiners in setting papers, either for the civil service or in technical schools, and to students preparing for examinations for the various positions covered.

Steel Castings.

Open Hearth Steel Castings. By W. M. Carr. Size, 8 by 5½ in.; pp., 118. Ills. Cleveland, O.: The Penton Publishing Company.

A series of practical papers on the methods involved in the manufacture of open-hearth steel castings by the basic and acid processes, compiled from articles written by the author for *The Iron Trade Review* and *The Foundry*.

BOOKS RECEIVED.

Die Ausnutzung der Wasserkräfte. By E. Mattern. Size, 9½ by 6½; pp., 260. Ills. Leipzig: Wilhelm Engelmann.

Das Praktische Jahr des Maschinenbau-Volontärs. By F. zur Nedden. Size, 8½ by 6½ in.; pp., 234. Berlin: Julius Springer.

Der Thermodynamik der Dampfmaschinen. By Fritz Krauss. Size, 8 by 5½ in.; pp., 144. Ills. Price, M. 3. Berlin: Julius Springer.

The Sanitary Evolution of London. By Henry Jephson. Size, 9 by 6 in.; pp., 440. Price, $1.80. Brooklyn, N. Y.: A. Wessels Company.

Details of Mill Construction. By Hawley Winchester Morton. Size, 12½ by 9½

in.; Plates, 25. Boston, Mass.: Bates and Guild Company.

Computation and Mensuration. By P. A. Lambert. Size, 7½ by 5 in.; pp., 92. Ills. Price, 80 cents. New York: The Macmillan Company.

Concrete Country Residences. Second Edition, 1907. Size, 12¾ by 10 in.; pp., 168. Ills. Price, $1. New York: The Atlas Portland Cement Company.

Quick Rules for Heating and Ventilating. By Wm. J. Baldwin, Jr. Size, 6 by 4½ in.; pp., 23. Price, $1. New York, N. Y.: Wm. J. Baldwin, Jr.

Annual Report of the Department of Public Works of the City of Buffalo, N. Y. Size, 9 by 6 in.; pp., 1094. Buffalo, N. Y.: Department of Public Works.

Fifth Annual Report of the State Board of Public Roads, Rhode Island, 1907. Size, 9 by 6 in.; pp., 39. Ills., 58. Providence, R. I.: Department of Public Roads.

Report of the State Engineer and Surveyor, State of New York, 1905. Size, 9 by 6 in.; pp., 775. Ills. Maps. Albany, N. Y.: State Engineer and Surveyor.

The Six-Chord Spiral. By J. R. Stephens. Size, 7½ by 5 in.; pp., 68. Ills. Cloth, $1.25; boards, $1. New York: The Engineering News Publishing Company.

Specifications for Street Roadway Pavements. By S. Whinery. Size, 9 by 6 in.; pp., 56. Price, 50 cents. New York: The Engineering News Publishing Company.

Power Stations and Power Transmission. By George C. Shaad. Size, 9½ by 6½ in.; pp., 150, v. Ills. Price, $1. Chicago: American School of Correspondence.

Annual Reports of the Department of the Interior, 1905; Commissioner of Education, Vol. 2. Size, 9 by 6 in.; pp., 657 to 1400. Washington, D. C.: Department of the Interior.

Report of the Fire Department of the City of New York for the Quarter and Year Ending December 31, 1906. Size, 10 by 7 in.; pp., 319. New York: Fire Department.

The Finances of Gas and Electric Light and Power Enterprises. By William D. Marks. Fourth Edition. Size, 7 by 5½ in.; pp., 540. Price, $4. New York: William D. Marks.

The Elements of Mechanics. By W. S. Franklin and Barry Macnutt. Size, 8½ by 6 in.; pp., xi, 283. Ills. Price, $1.50. New York: The Macmillan Company; London: Macmillan and Company, Limited.

The Problem of Flight, a Text-Book of Aerial Engineering. By Herbert Chatley. Size, 9 by 6 in.; pp., 119. Ills. London: Charles Griffin and Company, Limited; Philadelphia, Pa.: J. B. Lippincott Company.

The Thermo-Dynamic Principles of Engine Design. By L. M. Hobbs. Size, 8 by 5½ in.; pp., 143. Ills. Price, $1.75. London: Charles Griffin and Company, Limited; Philadelphia, Pa.: J. B. Lippincott Company.

Sixth Annual Report of the Metropolitan Water and Sewerage Board, being Public Document No. 57, Massachusetts. Size, 9 by 6 in.; pp., vii, 253. Ills. Boston, Mass.: Metropolitan Water and Sewerage Board.

The Mineral Industry, its Statistics, Technology and Trade during 1906. Volume XV. Edited by Walter Renton Ingalls. Size, 9 by 6 in.; pp., xxiv, 954. Ills. Price, $5. New York and London: Hill Publishing Company.

Report on British Standard Systems for Limit Gauges for Screw Threads. Prepared by the Engineering Standards Committee and edited by the Secretary, Leslie S. Robertson. Size, 13 by 8 in.; pp., 19. Price, 1/-. London: Crosby Lockwood and Son.

Papers and Reports relating to Minerals and Mining comprising Statement by the Minister of Mines; Report on the Goldfields; Report on Coal-Mines; State Coal-Mines. Size, 13 by 8½ in.; pp., 200. Ills. Maps. Wellington, New Zealand: Department of Mines.

Substitution of the Electric Locomotive for the Steam Locomotive. By Lewis B. Stillwell and H. St. Clair Putnam. Reprint from Volume XXVI of the Transactions of the American Institute of Electrical Engineers. Size, 9 by 6 in.; pp., 301. Ills. Price, $1. New York: American Institute of Electrical Engineers.

Report of the Fuels Committee of the Motor Union of Great Britain and Ireland, Together with the Evidence of Witnesses, and Memoranda on Petroleum, Petroleum Spirit, Paraffin, Shale, Benzol, Alcohol, etc., and a Bibliography. Size, 11 by 8½ in.; pp., 27. Price, 1/-. London: The Motor Union of Great Britain and Ireland.

Lubrication and Lubricants. A Treatise on the Theory and Practice of Lubrication. By Leonard Archbutt and R. Mountford Deeley. Second Edition, thoroughly revised and enlarged. Size, 8½ by 5½ in.; pp., xxx, 538. Ills. Price, $6. London: Charles Griffin and Company, Limited; Philadelphia, Pa.: J. B. Lippincott Company.

Supplement to the Report of the State Engineer and Surveyor, State of New York, 1905. History of the Canal System of the State of New York, together with Brief Histories of the Canals of the United States and Canada. By Noble E. Whitford. Two Volumes. Size, 9 by 6 in.; pp., 1547. Ills. Albany, N. Y.: State Engineer and Surveyor.